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Peter Wilkens - In Memoriam
Coral Reproduction, Part 3
Micro-Ecosystems
Total Organic Carbon, Part 2

photographs by Terry Siegel

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ADVANCED AQUARIST'S ONLINE MAGAZINE

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EDITORIAL

SEPTEMBER 2008

By Terry Siegel

Peter Wilkens -- In memoriam.

Published September 2008, Advanced Aquarist's Online Magazine.

Keywords (AdvancedAquarist.com Search Enabled): Editorial, Terry Siegel
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By Jean-Jacques Eckert:

Peter Wilkens was born 30/04/1937 in Sonderhausen near Weimar (Germany). At a young age he was an enthusiastic aquarist. Before 1960 his interest was primarily devoted to the conservation of marine organisms coming from all the oceans. During and after his studies of biology carried out in Heidelberg, he worked in the laboratories of the Federation of the Ruhr and various other industrial companies in the field of chemical analyses and bacteriologies of water and the examination of water. He belonged to the Berlin Marine Association in the company of Dietrich Stüber, who was credited for the so-called Berliner method. The knowledge acquired during this work constituted the important basis for his research concerning the invertebrates and fish appropriate for the aquarium as well as the general problems involved in the conservation of marine animals. Many research trips were carried out along the coasts of the Atlantic, of the whole of the Mediterranean, the Red Sea, and the Indo-Pacific. He made vast contributions concerning the world of the marine invertebrates in German and foreign specialized magazines, along with many conferences supported with slides taken during these trips. This conferred on him the worldwide reputation of an extraordinary specialist with regard to invertebrates. In the middle of the Eighties there did not exist literature concerning the maintenance of the corals. In beginning of the year 1970 he published his first book for aquarists "Niedere Tiere im tropischen Meeresaquarium" (The Saltwater Aquarium for Tropical Marine Invertebrates), in which he described the care necessary for the conservation of many corals and other marine invertebrates, who until this moment were regarded as impossible to maintain out of the ocean. What Wilkens presented with this book constituted a true revolution, which finally opened the door so that we today are able to maintain our reef tanks. In the era preceding Peter Wilkens there were few invertebrates that aquarists were able to maintain in aquaria. The spectrum of the invertebrates, which one could maintain successfully a long time was at that time very restricted and was generally limited to sea urchins, hermit crabs and sea anemones. The revolutionary work of Peter Wilkens was in his recognition of the biochemical requirements of a much wider range of conditions necessary to their survival. He began to develop methods regarding lighting, calcium supplementation via the use of kalkwasser (lime water) and methods for the removal of waste products, for example the use of protein skimming and activated carbon. He developed his knowledge and techniques through experimentation in his small store in Winterthur, Switzerland. I have visited it, I can affirm that it was a tiny room, not filled with unnecessary technology. Peter truly had a salty thumb. It is here that he created since 1970 his first trace element additive, CombiSan, marketed in 1979 which is still used by reef keepers. He was also the one who made the reef keeping world aware of the role of calcium for corals and developed the method of using Kalkwasser which is still used by most aquarists. He also developed carbon in pellet form, but this work is less known. Many aquarists from all over the world followed this new philosophy. Aquarists following his lead carried out research concerning the environment of the corals in order to improve their conservation within a closed system aquarium, while always following the principles that Peter Wilkens had formulated. Soon collaboration between amateurs and scientists intensified and an industry developed worldwide that brings us to today, where aquarists maintain beautiful reef tanks and public aquariums have built huge indoor reef tanks, essentially using the methods developed by Peter Wilkens. Peter Wilkens contribution both to science and the science of reef keeping is without peer. He has just left us after a long illness against which he fought but which did not leave him any chance. Finally, Peter Wilkens was a man who enjoyed great literature, the study of history [he wrote several historical novels], philosophy, fine food, and fine wine. Goodbye Peter, we miss you already.

Jean-Jacques Eckert

Peter and I became good friends. He visited me in Brooklyn, NY, where he was surprised to find that some good beer brewed by micro-brewers was available in the US. He also visited me on Cape Cod, where the picture included here was taken. Several years before that he, Julian Sprung, and I went collecting in the Bahamas. I still have gorgonians that we collected on that trip. Those were days that I will never forget, and Peter Wilkens was a man that I and the world will never forget.

Peter Wilkens at Breakwatter LZ.

FEATURE ARTICLE

Coral Reproduction, Part Three: Stony Coral Sexuality, Reproduction Modes, Puberty Size, Sex Ratios and Life Spans

By Dana Riddle

Information on the reproductive habits of over 300 stony coral species (in almost 100 genera) is presented. It is the most complete single-source reference currently available.

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The ultimate challenge of reefkeeping is the closing of our captive animals' life cycles. A fortunate few have witnessed a coral spawning in their aquariums and might be interested in what it would take to raise coral planula larvae. On the other hand, there may be dedicated hobbyists interested in captive spawning of a certain species. It is the goal of this series to assist those hobbyists. This time, we'll examine reproductive habits of stony corals. Information on the reproductive habits of over 300 stony coral species (in almost 100 genera) is presented. It is the most complete single-source reference currently available. This article will begin to offer information about other factors (puberty age and size, life spans, etc.) and should begin to answer questions hobbyists might have.

Witnessing coral reproduction, especially in an aquarium, is an exciting event. The first inclination is usually to find the camera and document the event. In the rush, some details may be (and often are) left unrecorded. Afterwards, many questions will inevitably arise. See the Figure 51 at the end of this article for suggestions on what to record.

There are several reasons why we don't hear of corals' sexual spawning in captivity, and the most likely reason is that few, if any, aquarists have specially tried to address issues pertinent to success. Another reason is that spawning events are simply not observed. It is also a fact that only a handful of dedicated aquarists have sufficiently researched requirements for captive breeding.

The goals of this third article on coral reproduction are simple. We'll examine the information available on stony coral sexuality and reproductive habits. This, in turn, will allow us to decide how many corals we'll likely need in order to have a pair (if necessary!). Sexual maturity is another issue. Unfortunately, we can not always judge the reproductive fitness of a coral simply by examining colony size - other factors are sometimes important (colony thickness is an important diagnostic tool in some small encrusting corals).

Be aware that benthic marine invertebrates as a group utilize almost every reproductive strategy imaginable, ranging from parthenogenesis (suggested by researchers to possibly occur in a few coral taxa) to other asexual means (including 'popping', 'dripping', 'budding', fragmentation, transverse fission, longitudal fission, stoloniferous growths, etc.) and, of course, sexual reproduction including broadcast spawning and brooding (both internally and externally). As usual, nature will continue to confound us as we realize that a particular coral species reproductive habit can, and often does, vary according to location and/or environmental conditions. However, this should not prevent us from reviewing reproduction data gathered from over 400 references (a complete reference list will appear at the end of this series).

To recap, our goals for this time are:

1. Discuss tools to ID your stony coral to the species level.
2. Understand its mode(s) of reproduction and with this information select the number and size of specimens to ensure a pair exists.
3. Enable you to select an appropriate aquarium size. (Be aware that many corals' size at puberty might make them much too large for some home aquaria.)

Before continuing, perhaps a review is in order of terminology we'll use.

Glossary

Brooding or Brooder - Brooding
: Where fertilized eggs are held internally (or sometimes on the surface of a parent colony) and are released as planula larvae. Brooder: A coral that uses the brooding reproductive process.

Fecundity
: Fertility; ability to produce abundantly.

Gonochoric
: Possessing distinct male and female colonies where offspring are a result of fusion of gametes. Also referred to as dioecious, or unisexual. Gonochorism occurs in ~25% of coral species examined (Richmond, 1997).

Hermaphroditic
Possessing both male and female reproductive organs, sometimes referred to as monoecious. Self-fertilization (also called 'selfing') is an uncommon hermaphroditic trait among corals.

Oocyte
An immature egg (ovum).

Parthenogenesis
Development of a new individual from an unfertilized egg. This results in a female clone and is thought to occur in many invertebrates (including soft corals, gorgonians and possibly stony corals) and some vertebrates.

Planula larvae
The free-swimming, ciliated stage of coral larvae.

Polyspermy
Where more than one sperm fertilizes an ovum.

Protandrous hermaphrodite
Where male sex organs mature before those of the female.

Protogynous
(proto=first; gynous = female) - Where female sex organs mature before those of the male.

Self-fertilization or 'Selfing'
Where gametes from a single parent colony are sufficient for successful reproduction. Relatively uncommon.

An Initial Recommendation

Unless you've witnessed a spawning of a particular coral species within your aquarium and want to investigate further, it is probably best to choose a coral that utilizes the brooding strategy. There are many advantages:

1. Brooding coral species are generally smaller in size than their broadcasting counterparts.
2. Planula larvae from brooders are relatively mature upon release and have the advantage of size.

Figure 1. A female Sandalolitha robusta specimen spawns at the Waikiki Aquarium. Photo courtesy Dr. Bruce Carlson.

3. Some hermaphroditic brooders do not broadcast gametes. This lessens the chance of the aquarium's life support system suffering catastrophic failure.
4. Brooded larvae sometimes contain zooxanthellae upon release from the parent colony, and the larvae do not have to obtain them from the surrounding environment.

Suspected Parthenogenesis

Parthenogenesis (definition above) is known to occur in a few invertebrates and even some vertebrates. It is suspected to occur in these stony corals:

- *Pocillopora damicornis* (Permata et al., 2000)
- *Porites lobata* (Fadllalah, 1983)
- *Porites lutea* (Fadllalah, 1983)
- *Fungia scutaria* (Krupp, 1983)

Self-fertilization ('selfing')

- *Acropora (Isopora) brueggemanni* (Okubo et al., 2007)
- *Acropora tenuis* (Heyward and Babcock, 1986)
- *Agaricia agaricites* (Gleason et al., 2001).
- *Balanophyllia europaea* (Goffredo et al., 2005).
- *Diploria strigosa* (Hagman et al., 1998, in Alvarado et al., 2003)
- *Favia fragum* (numerous references)
- *Goniastrea aspera* (Heyward and Babcock, 1985)
- *Goniastrea favulus* (Stoddart et al., 2004; Miller & Mundy, 2005)
- *Mycetophyllia* species, suspected (Tirado, 2006)
- *Pocillopora damicornis* (numerous references)
- *Porites astreoides* (Gleason et al., 2001).
- *Seriatopora hystrix* (Sherman, 2008)
- *Siderastrea radians* (Neves et al., 2008)
- *Tubastraea coccinea* (numerous references)

Gonochoric Brooding

Gonochoric brooding involves broadcast spawning by males and internal or external (surface) fertilization of oocytes, followed by internal or surface brooding:

- *Balanophyllia regia* (Goffredo et al., 2005)
- *Dendrophyllia* sp. (Babcock et al., 1986)
- *Goniopora queenslandiae* (Yamazato et al., 1975, in Fadlallah, 1983)

- *Isophyllia dipsacea* (Duerden, 1902, in Fadlallah, 1983)
- *Leptopsammia pruvoti* (Kruzic et al., 2008)
- *Porites brighami* (Richmond & Hunter, 1990)
- *Porites clavaria* (Fadlallah, 1983)
- *Porites furcata* (Soong, 1991)
- *Porites murrayensis* (Neves, 1998)
- *Porites panamensis* (Glynn et al., 2008)
- *Scolymia wellsi* (suspected; Pitombo, 1992)
- *Tubastraea faulkerni* (Babcock, 1986)

Brooders (stony corals)

- *Acrhelia horrescens* (Kawaguti, 1941)
- *Acropora (Isopora) brueggemanni* (see Richmond & Hunter, 1990)
- *Acropora corymbosa* (Stimson, 1978)
- *Acropora (Isopora) cuneata* (Wallace et al., 2007)
- *Acropora humilis* (Stimson, 1978)
- *Acropora palawensis* (see Richmond & Hunter, 1990)
- *Acropora (Isopora) palifera* (Kojis, 1986)
- *Acropora striata* (Stimson, 1978)
- *Acropora (Isopora) togianensis* (Wallace et al., 2007)
- *Agaricia agaricites* (Thornhill et al., 2006)
- *Alveopora daedalea* (Schlesinger & Loya, 1985)
- *Balanophyllia europaea* (Mezzomonaco et al., 2002)
- *Caryophyllia cyathus* (Koch, 1897)
- *Cyphastrea ocellina* (Stimson, 1978)
- *Dendrophyllia manni* (see Richmond & Hunter, 1990)
- *Diploria strigosa* (Hagman et al., 1998)
- *Euphyllia glabrescens* (Kawaguti, 1941)
- *Favia fragum* (Szmant, 1986)
- *Galaxea aspera* (see Richmond & Hunter, 1990)
- *Goniopora queenslandiae* (Loya, 1976)
- *Heliofungia actiniformis* (see Richmond & Hunter, 1990)
- *Isophyllia dipsacea* (Fadllalah, 1983)
- *Isopora togianensis* (Wallace et al., 2007)
- *Madracis carmabi* (Vermeij et al., 2004)
- *Madracis decactis* (Vermeij et al., 2004)
- *Madracis formosa* (Vermeij et al., 2004)
- *Madracis mirabilis* (Vermeij et al., 2004)
- *Madracis pharensis* (Vermeij et al., 2004)
- *Madracis senaria* (Vermeij et al., 2004)
- *Manicina areolata* (Johnson, 1992)
- *Mycetophyllia ferox* (Babcock et al., 1986)
- *Pocillopora damicornis* (Stimson, 1978)
- *Pocillopora elegans* (Stimson, 1978)
- *Pocillopora verrucosa* (Stimson, 1978)
- *Porites astreoides* (Thornhill et al., 2006)
- *Porites panamensis* (Glynn et al., 2008)
- *Scolymia wellsi* (Pitombo, 1992)
- *Seriatopora caliendrum* (Rinkevich & Loya, 1979)
- *Seriatopora hystrix* (multiple references)
- *Siderastrea radians* (Thornhill et al., 2006)
- *Tubastraea coccinea* (Glynn et al., 2008)

Protandrous and Protogynous Hermaphrodites

Protandrous Hermaphrodites

- *Flabellum rubrum* (Moseley, 1881, in Fadlallah, 1983)
- *Goniastrea favulus* (Kojis and Quinn, 1981)
- *Stylophora pistillata* (Loya, 1976)

Protogynous Hermaphrodite

- *Siderastrea radians* (Duerden, 1902, in Fadlallah, 1983)

Degree of Difficulty

As we have seen, aquarists have been successful in propagating a number of coral species. There are a number of factors involved in these successes, beginning with the skill and dedication of the aquarist. Seasoned veterans often report 'easy' asexual reproduction of species difficult to maintain long-term in captivity (some *Goniopora* species are good examples, while there are no reports of reproduction of easily maintained species).

With that said (and avoiding the issues and degrees of difficult in husbandry of some coral species), I will unilaterally list my perception of how challenging captive breeding of corals could be (beginning with the least difficult):

1. Those capable of *Parthenogenesis.*

2. *Programmed fragmentation.* This method is essentially left to the coral (it is genetically programmed to produce colonies in this manner), and fragments 'drip' or 'pop' away. The only thing required from the hobbyist is securing the cloned colony to a suitable substrate.

3. *Intentional fragmentation.* This technique requires little from the hobbyist. Small fragments, or nubbins, or snipped, clipped, sliced or cut away from brood stock and attached to any of a number of substrates for grow-out.

4. *Brooding coral colonies capable of self-fertilization or 'selfing'.* Since 'selfing' is due to fertilization of an egg produced by a female by a sperm produced by a male within the same colony or sometimes the same polyp (hermaphroditic), these bisexual coral colonies can reproduce with only one colony present.

5. *Hermaphroditic brooding corals.*

6. *Hermaphroditic broadcast spawners.* In theory, only two coral colonies would be required to ensure cross-fertilization. However, many variables come into play such as sperm concentrations, polyspermy, egg buoyancy, impact of spawning on aquarium water quality, mode of zooxanthellae acquisition (vertical or horizontal), etc.

7. *Gonochoric broadcast spawners.* In addition to the challenges presented by hermaphroditic broadcast spawners (above), we have to consider sex ratios (sometimes heavily skewed towards males) and the impact this has on sizing the aquarium.

Comments on Data Bases

While research this article, I found it best to maintain two data bases, and both are presented in this article. First, reproductive information about stony corals is listed in taxonomic order - by Family, Genus and Species along with comments, photographs, etc. After that, a quick reference sheet (along with the reference) presents reproductive information sans photos and comments (See Table 108).

A Note on Caribbean Corals

There have been rumors for a number of years that Caribbean corals would become legally available to hobbyists. After a number of false starts, this seems to be a reality. Rose corals (*Manicina areolata*) are available, and *Siderastrea* species may soon follow (Michael Janes, personnel communication. See www.aquatouch.com for details). *Acropora palmata* spats (grown from legally collected eggs and sperm from spawn slicks) are now in public aquaria. Perhaps this endangered species will someday be in home reef aquaria.

It has been estimated that 60% of Caribbean corals are brooders; some are of relatively small size and may be available in the future. For these reason, I have included Caribbean species in this article.

The Aquarium

Almost every article written on home-based fish propagation begins with aquarium selection. So, it is seems reasonable to start there, right? "Let's see - I've got that old 40 gallon breeder tank just gathering dust. I could use it…"

Whoa, cowboy! This line of reasoning has already dismissed the idea of logically thinking this project through from concept to reality. Fish breeders can choose the correct aquarium because they know much more about their fishes' reproductive habits than coral farmers know about their corals'. It is fairly easy to quickly research size of adult fish and how to sex them. So, let's start over.

Selecting Your Coral

Before you select your candidate coral, you should be able to identify it. There is a great deal of published research available (some of it presented in this series of articles), but utilization of this information depends upon correct identification of the coral. In some cases and with enough experience, this is simple. Some corals, such as the Elegance coral (*Catalaphyllia jardineri*), are not easily confused with any other species. Other corals will demonstrate a plasticity in shape and appearance according to environmental factors (water motion and lighting being two major influences), or naturally resemble very closely another coral species. For instance, there are several *Acropora* species that have pronounced corallites that appear to the casual viewer to be *Acropora millepora*, when in fact they are not.

Coral Identification Resources

Coral ID Software

Unless your stony coral identification skills are well-honed, I recommend the purchase of Veron's *Coral ID* software. See the Media Review on this excellent resource for stony coral species identification here (http://www.advancedaquarist.com/2008/4/review).

Internet Resources

For *Acropora* species, there is an excellent *free* resource on the internet (www.coralsee.org).

Veron's *Corals of the World* is available for *free* at this website: http://whelk.aims.gov.au/coralsearch/coralid-search.php

Note this website is easier to use if you *already* know the coral ID to genus level. Then it is a matter of looking at each species. This can be a time consuming matter, and definitely is not as easy to reference as the print version.

If getting an ID to the genus level is acceptable, see CoralIdea (www.coralidea.com).

Books

There is no better book than Veron's *Corals of the World* (2000). See the review of this book here (http://www.advancedaquarist.com/2008/4/review).

With a little practice and a few basic laboratory tools (magnifying glass, dissecting microscope) you should be able to get a reasonable idea as to the correct species (it helps if you know where the corals were collected - keep this in mind if you order through any of the major distributors. They know!).

Can I Use Fragments? Effect of Damage (Fragmentation) on Fecundity

It is generally believed that growth, reproduction and maintenance are processes competing for a limited amount of energy. The effects of breakage on a particular colony depend upon the amount of damage, colony size, energy reserves (such as lipids), environmental conditions and other factors. Limited resources could be devoted to repair traumatized areas. It is also possible that corals will re-absorb oocytes/eggs to obtain their high-calorie yolks for use in tissue repair.

There are several published papers on the subject. Zakai (1997) found that breakage of *Pocillopora damicornis* exceeding 25% of colony area reduced planulation by 63% while having no effect on the size (but obviously the number) of planulae. Smith and Hughes, 1999 examined the effects of breakage on *Acropora intermedia*, *Acropora millepora*, *Acropora hyacinthus* and found that fecundity was greatly reduced.

However, fragmentation does not necessarily reduce fecundity. Daughter colonies produced by programmed fragmentation by *Diaseris distorta* are sexually functional at sizes as small as 1 cm^2 (roughly ½" square). See Part 1 of this series for photos of *Diaseris*.

In general, fragments can be used, but expect fecundity to be reduced or delayed.

Polyp Anatomy

The sexual organs of corals are usually on mesenterial filaments within the polyp. See Figure 2.

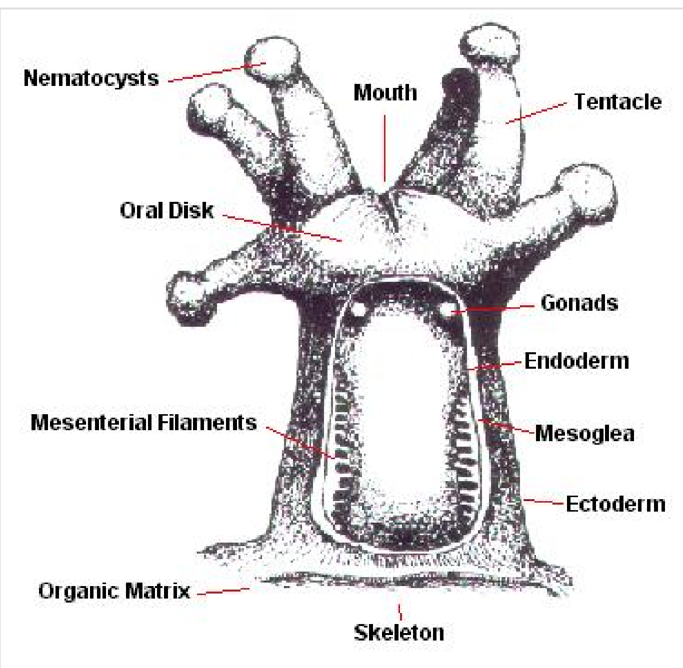

Figure 2. Anatomy of a 'typical' stony coral polyp. Eggs (oocytes) and spermaries (male gonads) - either separately or together - can be found on mesenteries within sexually mature polyps.

Sexing Your Coral

After selecting your target species, we can continue. Unfortunately, you can't just look at a coral and determine if it is male or female (unless you have the good fortune to witness it in the act of spawning, or have a small laboratory devoted to histology and can examine coral gonads). We'll need to understand a couple of terms before we continue.

Spawning Ratios - How Many of Each Species in an Aquarium?

Most corals are hermaphroditic and only in relatively few cases do we have to concern ourselves with the issue of sex ratios. Sex ratios, when available, are included in the initial reports (below). Be aware that sex ratios are not fixed and can vary from location to location, but this is the best information we currently have.

Notes on Colony Size, Sexual Maturity and Life Span

Colony size and sexual maturity has been linked in some cases, but many factors other than colony area should be considered. In some cases, it is not the size of the colony but the thickness of the coral's encrustation over the substrate that is the telling factor. In other cases, corals can asexually reproduce by fission, where a portion of the colony becomes isolated from the parent. In some cases, total mass of the colony (such as gorgonians) should be considered in lieu of colony height.

Generally, corals are a long-lived bunch and it is not uncommon to hear reports of corals believed to be hundreds of years of age. However, local patterns (number of storms, temperature, anthropogenic impacts, etc.) can limit survival rates.

On the other hand, brooding corals tend to have relatively brief lives. They mature at an earlier age and smaller size. They produce fewer young, but these tend to be well developed with a higher chance of survival. In some cases, brooders are opportunistic colonizers.

We'll now begin our review of stony coral reproductive habits. They are listed by in alphabetical order by Family, followed by Genus (also in alphabetical order). Information on species is presented in any of the Tables and some of the Figures.

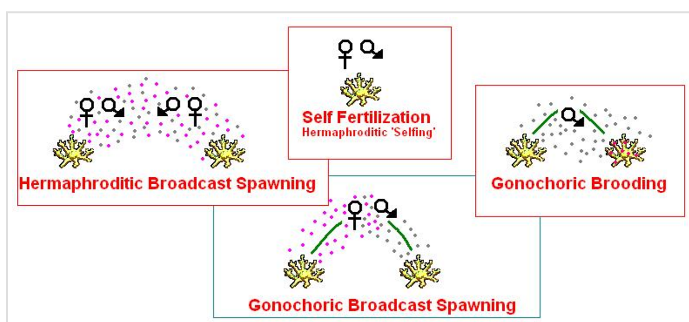

Figure 3. Modes of coral reproduction. 'Selfing' and 'gonochoric brooding' are relatively uncommon, while the two forms of broadcast spawnings are not.

For those wanting a quick reference, see the end of this article for Table 108 - The Quick and Easy Reference. There, corals are listed alphabetically by Genus.

Family Acroporidae

Genus *Acropora* (Staghorn and Antler Corals)

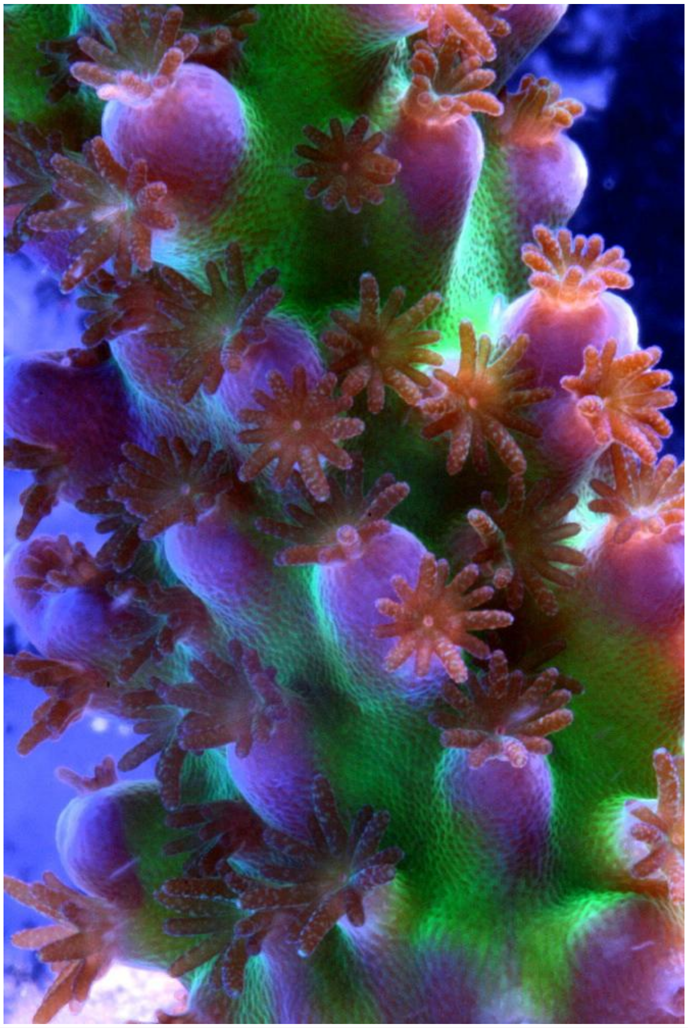

Figure 4. Acropora species are easily propagated via intentional fragmentation by hobbyists, but there are reports of sexual spawning in aquaria. Photo by the author.

See Table 1 for sexuality and reproductive modes of *Acropora* species (next page).

Puberty Age for *Acropora* Species

Table 2

Taxa	Puberty Size	Age	Reference
Acropora spp.	>20cm		Guest et al., 2005
Acropora spp.		3 years	Harrison & Wallace, 1990

Wallace (1985) estimates *Acropora granulosa*, *A. hyacinthus*, *A. loripes* and *A. valida* first spawn when they are 4-5 years of age. See Table 2 for more information.

Subgenus *Isopora*

Some controversy exists over 'subgenus' status of Isopora (some feel it should be elevated to genus status), but I'll present information as subgenus -as it is listed in the references - until this matter is resolved.

Table 3. Sexuality and reproductive Modes - Subgenus Isopora species.

Taxon	Sexuality	Reproduction
Acropora (Isopora) brueggemanni	Hermaphroditic	Brooder
Acropora (Isopora) cuneata	Hermaphroditic	Brooder
Acropora (Isopora) palifera	Hermaphroditic	Brooder
Acropora (Isopora) togianensis	Hermaphroditic	Brooder

Genus *Anacropora*

Table 4. Sexuality and reproductive Modes - *Anacropora* species.

Taxon	Sexuality	Reproduction
Anacropora matthai		Broadcast

Genus *Astreopora*

Table 5. Sexuality and Reproductive Modes - *Astreopora* species.

Taxon	Sexuality	Reproduction
Astreopora gracilis		Broadcast
Astreopora listeri		Broadcast
Astreopora myriophthalma	Hermaphroditic	Broadcast
Astreopora randalli	Hermaphroditic	Broadcast

Genus *Montipora*

Montipora species are very popular among reef hobbyists and for good reason. As a group, they are hardy and can grow quickly. In addition, some species contain colorful fluorescent and chromoprotein pigments (see Figure 5).

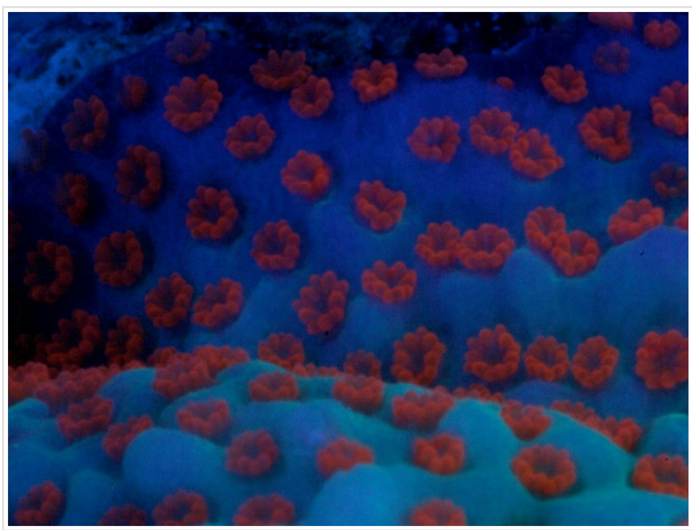

Figure 5. The fluorescence of Montipora danae. Photo by the author.

Table 1. Sexuality and reproductive Modes - *Acropora* species.

Taxon	Sexuality	Reproduction
Acropora aculeus	Hermaphroditic	Broadcast
Acropora acuminata		Broadcast
Acropora anthoceris	Hermaphroditic	Broadcast
Acropora aspera	Hermaphroditic	Broadcast
Acropora austera	Hermaphroditic	Broadcast
Acropora caroliniana		Broadcast
Acropora cerealis	Hermaphroditic	Broadcast
Acropora cervicornis	Hermaphroditic	Broadcast
Acropora clathrata	Hermaphroditic	Broadcast
Acropora corymbosa	Hermaphroditic	Brooder
Acropora cytheria	Hermaphroditic	Broadcast
Acropora danai	Hermaphroditic	Broadcast
Acropora delicatula	Possibly sterile	
Acropora delicatula	See *Acropora selago*	Broadcast
Acropora digitifera	Hermaphroditic	Broadcast
Acropora dilitata	Hermaphroditic	Broadcast
Acropora divaricata	Hermaphroditic	Broadcast
Acropora donei	Hermaphroditic	Broadcast
Acropora elseyi		Broadcast
Acropora eurystoma	Hermaphroditic	Broadcast
Acropora exquisita	Hermaphroditic	Broadcast
Acropora florida	Hermaphroditic	Broadcast
Acropora formosa	Hermaphroditic	Broadcast
Acropora gemmifera	Hermaphroditic	Broadcast
Acropora glauca	?	Broadcast
Acropora grandis	Hermaphroditic	Broadcast
Acropora grandulosa	Hermaphroditic	Broadcast
Acropora hemprichii	Hermaphroditic	Broadcast
Acropora horrida	Hermaphroditic	Broadcast
Acropora humilis	Hermaphroditic	Broadcast
Acropora humilis	?	Brooder
Acropora hyacinthus	Hermaphroditic	Broadcast
Acropora hystrix	Hermaphroditic	Broadcast
Acropora intermeda		Broadcast
Acropora irregularis	Hermaphroditic	Broadcast
Acropora jacquelineae		Broadcast
Acropora kimbeensis		
Acropora "kosurini-like"		Broadcast
Acropora latistella	Hermaphroditic	Broadcast
Acropora lianae		Broadcast
Acropora listeri		Broadcast
Acropora longicyathus	Hermaphroditic	Broadcast
Acropora loripes	Hermaphroditic	Broadcast
Acropora lutkeni	Hermaphroditic	Broadcast
Acropora microclados	Hermaphroditic	Broadcast
Acropora microphthalma	Hermaphroditic	Broadcast
Acropora millepora	Hermaphroditic	Broadcast
Acropora monticulosa	Hermaphroditic	Broadcast
Acropora muricata	Hermaphroditic	Broadcast
Acropora nana	Hermaphroditic	Broadcast
Acropora nastua	Hermaphroditic	Broadcast
Acropora nobilis	Hermaphroditic	Broadcast
Acropora ocellata	Hermaphroditic	Broadcast
Acropora palawensis	?	Brooder
Acropora palmata	Hermaphroditic	Broadcast
Acropora palmerae		Broadcast
Acropora papillare		Broadcast
Acropora plumosa		Broadcast
Acropora polystoma		Broadcast
Acropora pulchra	Hermaphroditic	Broadcast
Acropora robusta	Hermaphroditic	Broadcast
Acropora samoensis	Hermaphroditic	Broadcast
Acropora sarmentosa	Hermaphroditic	Broadcast

Taxon	Sexuality	Reproduction
Acropora scandens	Hermaphroditic	Broadcast
Acropora secale	Hermaphroditic	Broadcast
Acropora selago	Hermaphroditic	Broadcast
Acropora smithi	Hermaphroditic	Broadcast
Acropora solitaryensis	Hermaphroditic	Broadcast
Acropora spathulata		Broadcast
Acropora spicifera		Broadcast
Acropora squarrosa	Hermaphroditic	Broadcast
Acropora striata	?	Brooder
Acropora subulata		Broadcast
Acropora surculosa	Hermaphroditic	Broadcast
Acropora tenuis	Hermaphroditic	Broadcast
Acropora tortuosa	Hermaphroditic	Broadcast
Acropora valenciennesi	Hermaphroditic	Broadcast
Acropora valida	Hermaphroditic	Broadcast
Acropora variabilis	Hermaphroditic	Broadcast
Acropora vaughani		Broadcast
Acropora verweyi	Hermaphroditic	Broadcast
Acropora willisae		Broadcast
Acropora yongei	Hermaphroditic	Broadcast

Table 6. Sexuality and Reproductive Modes - *Montipora* species. Note that *M. dilitata, M. flabellate* and *M. patula* are endemic to Hawaii, thus restricting their distribution within the pet trade.

Taxon	Sexuality	Reproduction
Montipora aequituberculata	Hermaphroditic	Broadcast
Montipora altasepta	Hermaphroditic	Broadcast
Montipora cactus	Hermaphroditic	Broadcast
Montipora capitata	Hermaphroditic	Broadcast
Montipora crassituberculata	Hermaphroditic	
Montipora digitata	Hermaphroditic	Broadcast
Montipora dilatata	Hermaphroditic	Broadcast
Montipora efflorescens	Hermaphroditic	Broadcast
Montipora effusa		Broadcast
Montipora erythraea	Hermaphroditic	Broadcast
Montipora eydouxi	Hermaphroditic	Broadcast
Montipora faveolata	Hermaphroditic	Broadcast
Montipora flabellata	Hermaphroditic	Broadcast
Montipora floweri	Hermaphroditic	Broadcast
Montipora foliosa	Hermaphroditic	Broadcast
Montipora hispida	Hermaphroditic	Broadcast
Montipora informis	Hermaphroditic	Broadcast
Montipora monasteriata	Hermaphroditic	Broadcast
Montipora patula	Hermaphroditic	Broadcast
Montipora peltiformis		Broadcast
Montipora ramosa		Broadcast
Montipora samarensis	Hermaphroditic	
Montipora spumosa	Hermaphroditic	Broadcast
Montipora studeri	Hermaphroditic	Broadcast
Montipora tuberculosa		Broadcast
Montipora turgescens	Hermaphroditic	Broadcast
Montipora turtlenesis	Hermaphroditic	Broadcast
Montipora venosa	Hermaphroditic	Broadcast
Montipora verrilli	Hermaphroditic	Broadcast
Montipora verrucosa	Hermaphroditic	Broadcast

Puberty Size of *Montipora* Specimens

Bassim (1997) reports that *Montipora verrucosa* (now *M. capitata*) colonies are sexually mature when they are 18 cm (7.2") on the longest axis.

Family Agariciidae

Members of Agariciidae are a mixed bag, reproductively speaking (Veron, 1986) - *Agaricia* species are brooders, while *Pavona* species are broadcast spawners. We don't have enough information on other genera to make generalizations. Unfortunately, there is presently a ban on collection of *Agaricia* species, but *Pachyseris* and *Pavona* specimens are common in reef aquaria.

Genus *Agaricia* (Lettuce Leaf Corals)

Table 7. Sexuality and Reproductive Modes - *Agaricia* species.

Taxon	Sexuality	Reproduction
Agaricia agaricites	Hermaphroditic	Brooder
Agaricia crassa	?	Brooder
Agaricia fragilis	?	Brooder
Agaricia grahame	?	Brooder
Agaricia humilis	Hermaphroditic	Brooder
Agaricia lamarcki	?	Brooder
Agaricia purpurea	Hermaphroditic	Brooder
Agaricia tenufolia	?	Brooder
Agaricia undata	?	Brooder

Puberty Size of *Agaricia humilis*

Agaricia species are found only in the Caribbean (Veron, 1986). As far as we know, all *Agaricia* species are hermaphroditic brooders. *Agaricia humilis* specimens are sexually mature when they are ~28mm in diameter (van Moorsel, 1983). *A. humilis* is known to planulate year round. See Figure 6 for details on adult colony sizes.

Genus *Coeloseris*

No information on reproductive habits available.

GENUS *GARDINEROSERIS*

Table 8. Sexuality of *Gardineroseris planulata.*

Taxon	Sexuality	Reproduction
Gardineroseris planulata	Hermaphroditic	

GENUS *HELIOSERIS*

Table 9. Reproductive Mode of *Helioseris cucullata*.

Taxon	Sexuality	Reproduction
Helioseris cucullata		Brooder

GENUS *LEPTOSERIS* (RIDGE CORALS)

No information on reproductive habits available.

GENUS *PACHYSERIS*

Table 10. Sexuality and Reproductive Modes of *Pachyseris* species.

Taxon	Sexuality	Reproduction
Pachyseris rugosa	Gonochoric	Broadcast
Pachyseris speciosa	Gonochoric	Broadcast

GENUS *PAVONA* (PORK CHOP OR CORRUGATED CORALS)

Table 11. Sexuality and Reproductive Modes of *Pavona* species.

Taxon	Sexuality	Reproduction
Pavona cactus	Gonochoric	?
Pavona duerdeni	Gonochoric	Broadcast
Pavona explanata	Gonochoric (?)	
Pavona gigantea	Gonochoric	Broadcast
Pavona varians	Gonochoric	Broadcast

FAMILY ASTROCOENIIDAE

GENUS *MADRACIS*

Madracis species are cosmopolitan - they are found in the Pacific (including Hawaii), Atlantic and Mediterranean.

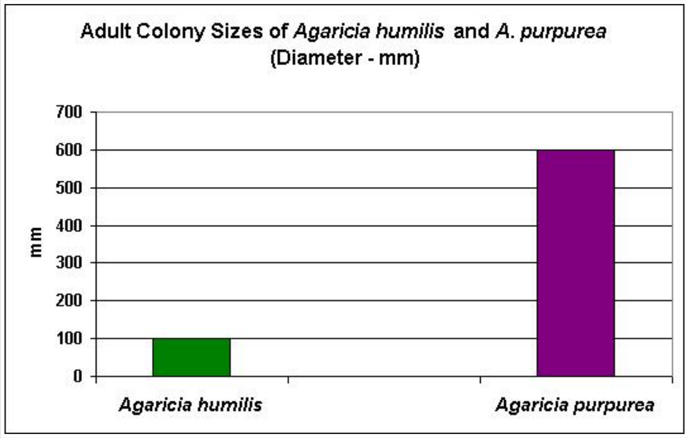

Figure 6. Diameters of adult Agaricia species (Van Moorsel, 1981).

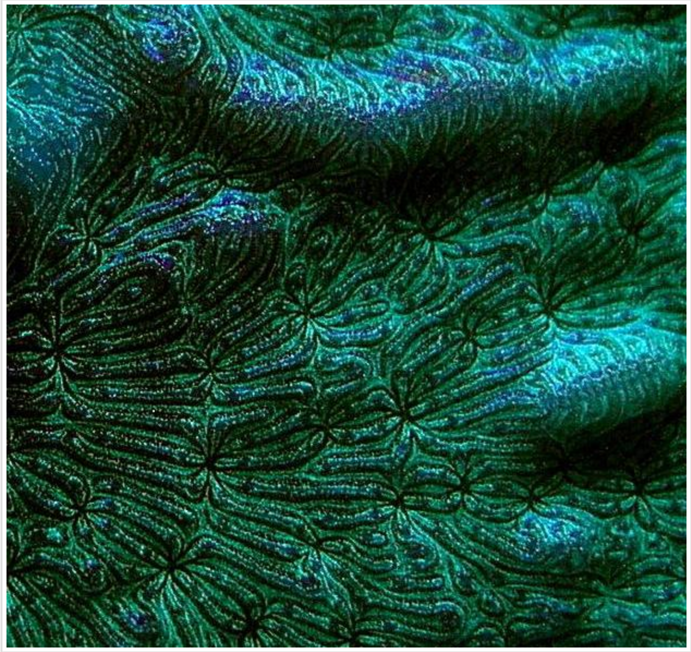

Figure 7. Pavona varians, from Hawaii. Photo by the author.

Table 12. Sexuality and Reproductive Modes of *Madracis* species.

Taxon	Sexuality	Reproduction
Madracis carmabi	Hermaphroditic	Brooder
Madracis decactis	Hermaphroditic	Brooder
Madracis formosa	Hermaphroditic	Brooder
Madracis mirabilis	Hermaphroditic	Brooder
Madracis pharensis	Hermaphroditic	Brooder
Madracis senaria	Hermaphroditic	Brooder

GENUS *PALAUASTREA*

Biologists seem to have overlooked this coral (it strongly resembles the common *Porites cylindrica*) and I have been unable to locate any information concerning its reproductive habits.

GENUS *STEPHANOCOENIA*

Table 13. Sexuality and Reproductive Modes of *Stephanocoenia* species.

Taxon	Sexuality	Reproduction
Stephanocoenia intercepta	Gonochoric	Broadcast
Stephanocoenia michelini	Gonochoric	Broadcast

GENUS *STYLOCOENIELLA*

Table 14. Sexuality of a *Stylocoeniella* species.

Taxon	Sexuality	Reproduction
Stylocoeniella sp.	Gonochoric	

Family Caryophylliidae

Genus *Heterocyathus*

A zooxanthellate coral (Veron, 2000). No information is available about reproductive habits.

Genus *Caryophyllia*

Table 15. Sexuality and Reproductive Modes of *Caryophyllia* species.

Taxon	Sexuality	Reproduction
Caryophyllia ambrosa (deep water)	Hermaphroditic	
Caryophyllia cornuformis (deep water)	Hermaphroditic	
Caryophyllia cyathus	?	Brooder
Caryophyllia sequenzae (deep water)	Hermaphroditic	
Caryophyllia smithi	Gonochoric	Broadcast

Genus *Goniocorella*

Table 16. Sexuality of a *Goniocorella* species.

Taxon	Sexuality	Reproduction
Goniocorella dumosa (deep water)	Gonochoric	

Genus *Lophelia*

Table 17. Sexuality of a *Lophelia* species.

Taxon	Sexuality	Reproduction
Lophelia pertusa (deep water)	Gonochoric	?

Family Dendrophylliidae

Some of the members of Dendrophylliidae are non-photosynthetic (they do not contain zooxanthellae). Since they are not autotrophic, some *Balanophyllia*, *Dendrophyllia*, *Tubastraea* and others require good water motion to deliver enough food, or require regular feedings. Those aquarists willing to meet the demands of these often brightly colored animals are often rewarded by their corals' captive spawnings (usually in the form of planula larvae).

Genus *Balanophyllia*

Balanophyllia europea (a Mediterranean coral) contains zooxanthellae. Other *Balanophyllia* species do not.

Table 18. Sexuality and Reproductive Modes of *Balanophyllia* species.

Taxon	Sexuality	Reproduction
Balanophyllia elegans	Gonochoric	Brooder
Balanophyllia europaea	Hermaphroditic	Brooder
Balanophyllia pruvoti	Gonochoric	
Balanophyllia regia	Gonochoric (?)	Brooder
Balanophyllia sp.		Brooder

Age of Puberty, Sex Ratio and Life Span for *Balanophyllia* species

Balanophyllia elegans colonies are capable of reproduction (brooding) at 1.5 years of age and have an expected life span of about 10 years (Gerrodette, 1981).

The gonochoric *Balanophyllia pruvoti* has a sex ratio of 1:1 (Radetic et al., 2002).

Genus *Cladopsammia*

Table 19. Sexuality and Reproductive Modes of *Cladopsammia rolandi*.

Taxon	Sexuality	Reproduction
Cladopsammia rolandi	Hermaphroditic	Brooder

Genus *Dendrophyllia*

Table 20. Sexuality and Reproductive Modes of a *Dendrophyllia* species.

Taxon	Sexuality	Reproduction
Dendrophyllia nigrescens	See *Tubastraea* spp.	
Dendrophyllia sp.	Gonochoric	Brooder

Genus *Duncanopsammia*

No information available on reproduction of the single member of this genus - *Duncanopsammia axifuga* (Veron, 1986).

Genus *Enallopsammia*

Table 21. Sexuality and Reproductive Mode of *Enallopsammia rostrata*.

Taxon	Sexuality	Reproduction
Enallopsammia rostrata (deep water)	Gonochoric	

Genus *Leptopsammia* (Sunset Cup Coral)

Table 22. Sexuality and Reproductive Mode of *Leptopsammia pruvoti*.

Taxon	Sexuality	Reproduction
Leptopsammia pruvoti	Gonochoric	Brooder

Genus *Heteropsammia*

These small (25mm diameter) corals live at depths of ~25 meters or more and are free-living on soft bottoms (Veron, 2000). They may or may not contain zooxanthellae.

Table 23. Sexuality and Reproductive Modes of *Heteropsammia* species.

Taxon	Sexuality	Reproduction
Heteropsammia aequicostatus	Gonochoric	Broadcast
Heteropsammia cochlea	Gonochoric	Broadcast

Genus *Rhizopsammia* (Wellington's Solitary Coral)

Table 24. Sexuality and Reproductive Modes of *Rhizopsammia minuta*.

Taxon	Sexuality	Reproduction
Rhizopsammia minuta		Brooder

Genus *Tubastraea* (Sun Corals)

Tubastraea (or perhaps *Dendrophyllia*) specimens reproduce readily in an aquarium when conditions are right.

Fully developed planula larvae are released and the number of reports of this occurrence in aquaria rivals that of another brooding coral - *Pocillopora damicornis*.

Table 25. Sexuality and Reproductive Modes of *Tubastraea* species.

Taxon	Sexuality	Reproduction
Tubastraea aurea	See *Tubastraea coccinea*	
Tubastraea coccinea	Hermaphroditic	Brooder
Tubastraea faulkneri	Gonochoric	Brooder

Puberty Size and Age of *Tubastraea coccinea*

Tubastraea coccinea (Glynn et al., 2008) Reproductive at 1.5 years, equating to colony size of ~5 cm in diameter, although Glynn et al., 2008 reports colonies can be reproductive when only 2 to 10 polyps are present (possibly due to stoloniferous growths). Paz-García et al. (2007) also reports reproduction in colonies only 5 cm in diameter (see Figure 11).

Genus *Turbinaria* (Pagoda Corals)

Veron, 1986 states that *Turbinaria* species are all gonochoric broadcast spawners.

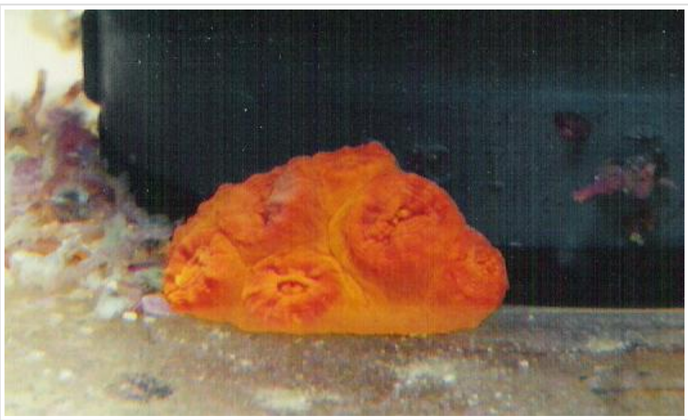

Figure 9. This Tubastraea colony originated from a planula larva that settled in an area of high flow - an overflow in a reef aquarium.

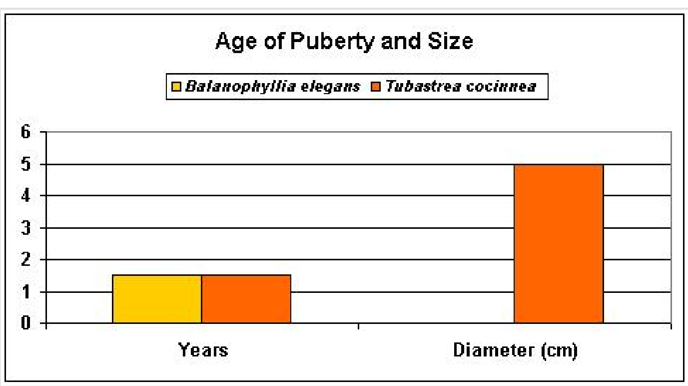

Figure 10. These Tubastraea and Balanophyllia species are sexually mature at an early age.

Figure 11. The distinctive yellow-green coloration of Turbinaria reniformis is visible in this specimen. Photo by the author.

Table 26. Sexuality and Reproductive Modes of *Turbinaria* species.

Taxon	Sexuality	Reproduction
Turbinaria frondens	Gonochoric	
Turbinaria mesenterina		Broadcast
Turbinaria reniformis	Gonochoric	Broadcast
Turbinaria sp.	Gonochoric	Broadcast

Family Euphyllidae

Family Euphylliidae contains some of the most popular aquarium corals including *Euphyllia* species (commonly called Anchor, Hammer, and Frogspawn corals) as well the Elegance coral (*Catalaphyllia jardinei*), Bubble and Grape corals (genera *Plerogyra* and *Physogyra*, respectively) and the Fox coral (*Nemenzophyllia*).

Euphylliidae corals, as a group, use various reproductive strategies as the following tables demonstrate.

Genus *Catalaphyllia* (Elegance Coral)

There is only one known *Catalaphyllia* species.

Table 27. Sexuality and Reproductive Modes of *Catalaphyllia jardeni.*

Taxon	Sexuality	Reproduction
Catalaphyllia jardinei	Gonochoric	Broadcast

Genus *Euphyllia* (Hammer, Anchor, and Frogspawn Corals)

Figure 12. Euphyllia ancora, a gonochoric broadcast spawner. Photo by the author.

Euphyllia species are of separate sexes (gonochoric) and broadcast gametes, except for the hermaphroditic brooder *E. glabrescens*. There are reports of *E. glabrescens* planulating and successful settlements of larvae within aquaria (Mitch Carl, personal communication).

Table 28. Sexuality and Reproductive Modes of *Euphyllia* Species.

Taxon	Sexuality	Reproduction
Euphyllia ancora	Gonochoric	Broadcast
Euphyllia divisa	Gonochoric	Broadcast
Euphyllia glabrescens	Hermaphroditic	Brooder
Euphyllia parancora	Gonochoric?	Broadcast
Euphyllia rugosa		Brooder

Figure 13. Release of planula larvae by a Euphyllia glabrescens at the Henry Doorly Zoo, Omaha, Nebraska. Photo courtesy Mitch Carl.

Maximum Colony Sizes of Brooding and Broadcasting *Euphyllia* Species

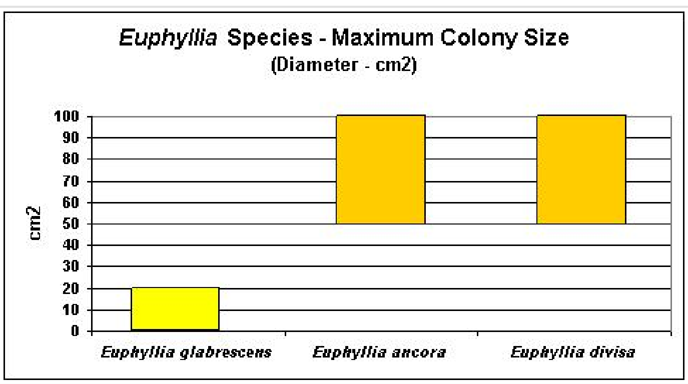

Figure 14. Euphyllia glabrescens is a hermaphroditic brooder, and is smaller than its broadcasting relatives. Note that 100 cm diameter may not be the largest colony size, it is the largest category listed by the researcher (Soong, 1993).

Genus *Nemenzophyllia* (The Fox Coral)

Some of the corals sold as *Nemenzophyllia* are likely *Plerogyra discus*. *Nemenzophyllia* is often listed as rare, and no information is available on its reproductive habits.

Genus *Physogyra* (Grape Coral)

The Grape coral is commonly seen in reef aquaria. It is a gonochoric, broadcast spawner.

Table 29. Sexuality and Reproductive Mode of *Physogyra lichtensteini*.

Taxon	Sexuality	Reproduction
Physogyra lichtensteini	Gonochoric	Broadcast

Genus*Plerogyra* (Bubble Coral)

The Bubble coral is another popular reef aquarium inhabitant. It is probably gonochoric, and definitely a broadcast spawner.

Table 30. Reproductive Mode of *Plerogyra sinuosa*.

Taxon	Sexuality	Reproduction
Plerogyra sinuosa		Broadcast

Figure 15. Nemenzophyllia turbida or Plerogyra discus? Only its taxonomist knows for sure. Photo by the author.

Figure 16. Hobbyists have reported that Bubble Corals (Plerogyra sinuosa) are broadcast spawners. Photo courtesy of Steve Ruddy.

Genus *Solenosmilia*

Table 31. Sexuality and Reproductive Modes of *Solensomilia variabilis*.

Taxon	Sexuality	Reproduction
Solensomilia variabilis	Gonochoric	Broadcast (?)

Family Faviidae

Genus *Astreosmilia*

Limited to the western Indian Ocean (Veron, 1986), few researchers have paid much attention to these corals, and no information on spawning habits is available.

Genus *Australogyra*

Table 32. Sexuality and Reproductive Mode of *Australogyra zelli*.

Taxon	Sexuality	Reproduction
Australogyra zelli	Hermaphroditic	Broadcast

Genus *Barabattoia*

Table 33. Sexuality and Reproductive Mode of *Barabattoia amicorum*.

Taxon	Sexuality	Reproduction
Barabattoia amicorum	Hermaphroditic	Broadcast

Genus *Caulastrea* (Candy Cane Corals)

Table 34. Sexuality and Reproductive Mode of *Caulastrea furcata*.

Taxon	Sexuality	Reproduction
Caulastrea furcata	Hermaphroditic	Broadcast

Genus *Cladocora* (Tube Corals)

Cladocora specimens are often found on Florida live rock but their patchy spots or clusters of small polyps are not particularly spectacular. Some do not possess zooxanthellae making their small tentacles colorless. Their 'tubes' are ~1/8" in diameter.

Table 35. Sexuality and Reproductive Mode of *Cladocora caespitosa*.

Taxon	Sexuality	Reproduction
Cladocora caespitosa	Hermaphroditic	Broadcast

Genus *Colpophyllia* (Grooved Brain Coral)

This genus is found only in the Atlantic (Veron, 1986).

Table 36. Sexuality and Reproductive Modes of *Colpophyllia* species.

Taxon	Sexuality	Reproduction
Colpophyllia amaranthus		Broadcast
Colpophyllia breviseralis		Broadcast
Colpophyllia natans	Hermaphroditic	Broadcast

Genus *Cyphastrea*

Table 37. Sexuality and Reproductive Modes of *Cyphastrea* species.

Taxon	Sexuality	Reproduction
Cyphastrea chalcidicum	Hermaphroditic	Broadcast
Cyphastrea microphthalma	Hermaphroditic	Broadcast
Cyphastrea ocellina	Hermaphroditic	Brooder
Cyphastrea seraila	Hermaphroditic	Broadcast

Maximum Colony Sizes of Various *Cyphastrea* Species

Information on maximum colony sizes of various *Cyphastrea* confirms once again that brooding corals are smaller in size than their broadcasting relatives. See Figure 18.

Genus *Diploastrea*

Table 38. Sexuality and Reproductive Mode of *Diploastrea heliopora*.

Taxon	Sexuality	Reproduction
Diploastrea heliopora	Gonochoric	Broadcast

Figure 17. Colpophyllia species. Photo courtesy Jake Adams and www.coralidea.com

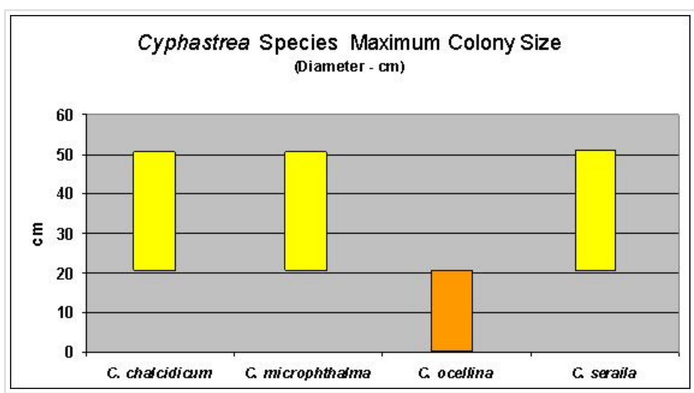

Figure 18. The brooder Cyphastrea ocellina has a smaller adult colony size than the Cyphastrea species that are broadcast spawners.

Genus *Diploria* (Brain Corals)

This genus is found only in the Atlantic (Veron, 1986), and it is possible that specimens could hitchhike in on legally collected live rock.

Table 39. Sexuality and Reproductive Modes of *Diploria* species.

Taxon	Sexuality	Reproduction
Diploria clivosa	Hermaphroditic	Broadcast
Diploria labyrinthiformis	Hermaphroditic	Broadcast
Diploria labyrinthiformis	Hermaphroditic	Brooder
Diploria strigosa	Hermaphroditic	Broadcast
Diploria strigosa	Hermaphroditic	Brooder

Sizes and Sexual Maturity of *Diploria clivosa* and *D. strigosa*

Figure 19. Adventurer and reef hobbyist John Dawe watches a Diploria spawn at the Flower Garden Banks, Gulf of Mexico. Egg/sperm bundles are visible as white dots throughout the picture. Photo courtesy of Michael P. Janes.

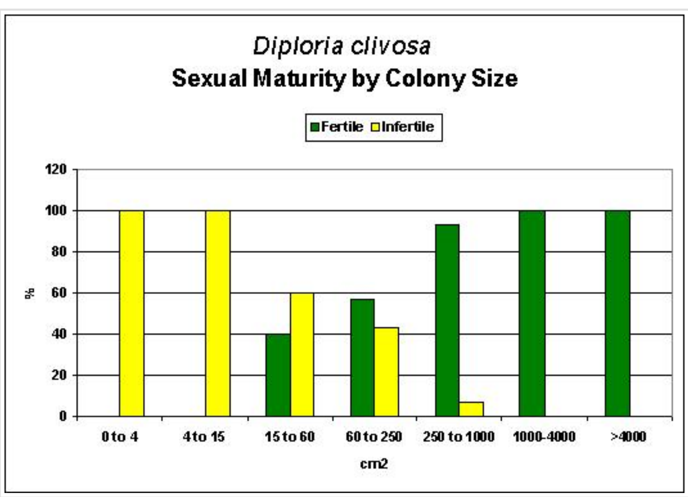

Figure 20. Diploria clivosa is a hermaphroditic broadcast spawner.

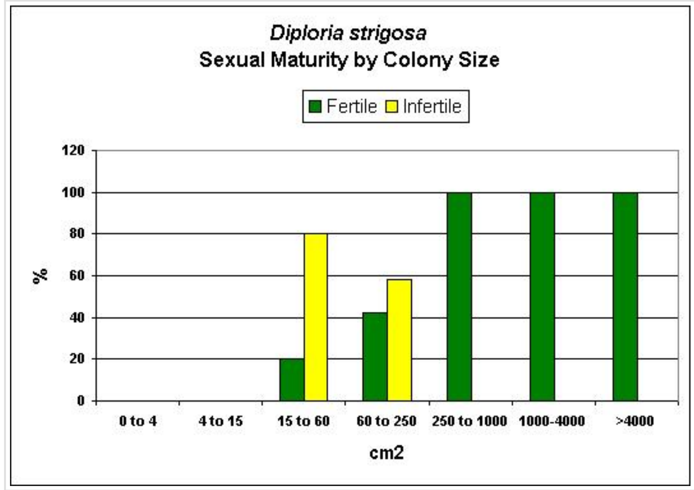

Figure 21. Diploria strigosa is a hermaphroditic brooder.

Table 40. *Diploria* Puberty Sizes and Ages

Taxa	Puberty Size	Age	Reference
Diploria clivosa	>100 cm^2	7-9 years	Soong, 1992
Diploria strigosa	>100 cm^2	7-9 years	Soong, 1992

Genus *Echinopora*

Table 41. Sexuality and Reproductive Modes of *Echinopora* species.

Taxon	Sexuality	Reproduction
Echinopora gemmacea	Hermaphroditic	Broadcast
Echinopora horrida	Hermaphroditic	Broadcast
Echinopora lamellosa	Hermaphroditic	Broadcast
Echinopora pacificus	Hermaphroditic	Broadcast

Genus *Erythrastrea*

This genus' distribution is limited to the Red Sea (Veron, 1986) and no information on its reproductive habits is available.

Genus *Favia* (Star Corals)

Favia corals have been a mainstay in the reef aquarium hobby for many years. There are scattered reports of reproduction in aquaria.

Table 42. Sexuality and Reproductive Modes of *Favia* species.

Taxon	Sexuality	Reproduction
Favia bennettae	Hermaphroditic	Broadcast
Favia doreyensis	Hermaphroditic	Broadcast
Favia favus	Hermaphroditic	Broadcast
Favia favus	Gonochoric	Broadcast
Favia favus	Hermaphroditic	Broadcast
Favia fragum	Hermaphroditic	Brooder
Favia helianthoides	Hermaphroditic	Broadcast
Favia laxa		Broadcast
Favia lizardensis	Hermaphroditic	Broadcast
Favia matthai	Hermaphroditic	Broadcast
Favia pallida	Hermaphroditic	Broadcast
Favia rotumana		Broadcast
Favia speciosa	Hermaphroditic	Broadcast
Favia stelligera	Hermaphroditic	Broadcast
Favia veroni	Hermaphroditic	Broadcast

Table 43. Size and maturity of several *Favia* species.

Taxa	Puberty Size	Age	Reference
Favia doryensis	?	8 years	Connell, 1973
Favia favus	~3.5 cm^2	4 years	Oren et al., 2001
Favia fragum	2- 4 cm^2	1.5 - 2 years	Soong, 1992

Notes on *Favia* Puberty Size and Age

- *Favia doryensis* specimens are sexually mature at 8 years of age (Connell, 1974).
- *Favia fragum* has reproduced in aquaria. It is a small coral (no more than 2" in diameter and broods its young).

Figure 22. A Favia specimen releases an egg or sperm bundle in the aquarium of master aquarist Tony Vargas. Photo courtesy of Tony Vargas. This Favia has been maintained in captivity since 2000, and is 8 inches in diameter. Spawning occurred in June 7, 2004 in the early morning, and the event lasted for ~1 hour. This coral had recently endured a move from New York to Florida.

Genus *Favites*

Table 44. Sexuality and reproduction modes of *Favites* species.

Taxon	Sexuality	Reproduction
Favites abdita	Hermaphroditic	Broadcast
Favites bennettae	Hermaphroditic	Broadcast
Favites chinensis	Hermaphroditic	Broadcast
Favites complanata	Hermaphroditic	Broadcast
Favites flexuosa	Hermaphroditic	Broadcast
Favites halicora	Hermaphroditic	Broadcast
Favites pentagona	Hermaphroditic	Broadcast
Favites russelli	Hermaphroditic	Broadcast

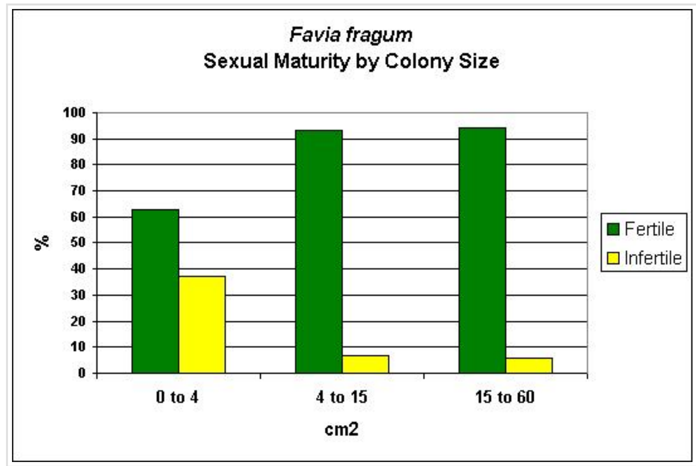

Figure 23. Favia fragum is known to reproduce in public aquaria. It is a brooder, matures at a small size (~ 50mm in diameter) and can be very attractive. Unfortunately, it is an Atlantic coral and is not readily available to hobbyists.

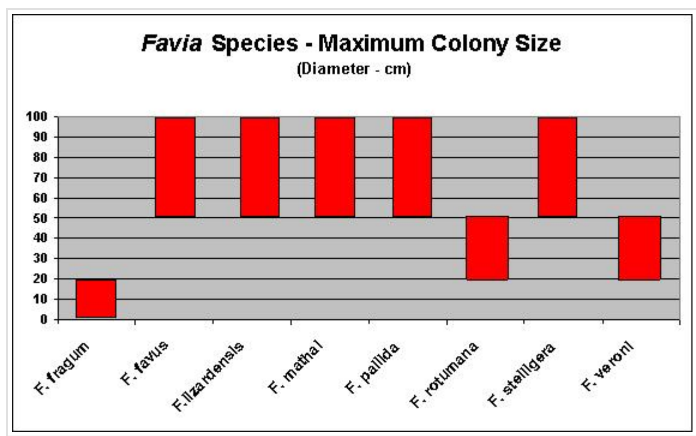

Figure 24. The trend continues… the brooding coral F. fragum is smaller than its broadcast spawning counterparts. Note that 100 cm diameter may not be the largest colony size, it is the largest category listed by the researcher (Soong, 1993).

Genus *Goniastrea* (Honeycomb Coral)

Table 45. Sexuality and reproduction modes of *Goniastrea* species.

Taxon	Sexuality	Reproduction
Goniastrea aspera	Hermaphroditic	Broadcast
Goniastrea aspera	Hermaphroditic	Brooder
Goniastrea australensis	Hermaphroditic	Broadcast
Goniastrea edwardsi	Hermaphroditic	Broadcast
Goniastrea favulus	Hermaphroditic	Broadcast
Goniastrea favulus	Protandrous Hermaphrodite	
Goniastrea palauensis	Hermaphroditic	Broadcast
Goniastrea pectinata	Hermaphroditic	Broadcast
Goniastrea retiformis	Hermaphroditic	Broadcast

Puberty Size and Age of *Goniastrea* Specimens

- *Goniastrea aspera* - less than 3"in diameter have only a slim chance of containing gonads, and proportion of mature colonies increases with colony size (Babcock, 1984)
- *Goniastrea aspera* and *G. favulus* reached reproductive age in about 5 years (Babcock, 1991).

Genus *Leptastrea*

Table 46. Sexuality and reproduction modes of *Leptastrea* species.

Taxon	Sexuality	Reproduction
Leptastrea bottae	Gonochoric	Broadcast
Leptastrea purpurea	Gonochoric	Broadcast

Genus *Leptoria*

Table 47. Sexuality and reproduction mode of *Leptoria phyria*.

Taxon	Sexuality	Reproduction
Leptoria phyria	Hermaphroditic	Broadcast

Genus *Manicina* (Common Atlantic Rose Coral)

These beautiful Caribbean corals are being legally reared and are beginning to find there way to market in the U.S. Their small size and reproductive habits make them an idea candidate for captive propagation efforts. See this website for details on obtaining *Manicina* specimens: www.aquatouch.com

Table 48. Sexuality and reproduction mode of *Manicina areolata*.

Taxon	Sexuality	Reproduction
Manicina areolata	Hermaphroditic	Brooder

Comment on *M. areolata* Adult Size

Adult *Manicina* specimens are ~3 inches long.

Genus *Montastrea* (Boulder Coral)

Montastrea corals are found in the Atlantic and Pacific Oceans.

Table 49. Sexuality and reproduction modes of *Montastrea* species.

Taxon	Sexuality	Reproduction
Montastrea magnistellata	Hermaphroditic	Broadcast
Montastrea annularis	Hermaphroditic	Broadcast
Montastrea annuligera	Hermaphroditic	Broadcast
Montastrea cavernosa	Gonochoric	Broadcast
Montastrea curta	Hermaphroditic	Broadcast
Montastrea faveolata	Hermaphroditic	Broadcast
Montastrea franksi	Hermaphroditic	Broadcast
Montastrea valenciennesi	Hermaphroditic	Broadcast

Age of Puberty for *Montastrea annularis*

Szmant (1986) estimates the age of puberty for *Montastrea annularis* is 5 to 6 years.

Figure 25. The Caribbean Rose Coral (Manicina areolata) is now legally available for purchase by hobbyists. Photo courtesy Jake Adams and www.coralidea.com

Figure 26. Montastrea cavernosa. Photo courtesy Jake Adams and www.coralidea.com

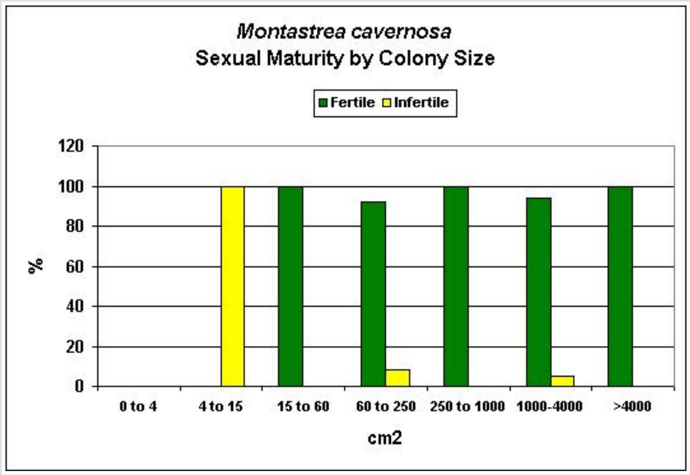

Figure 27. The Caribbean faviid Montastrea cavernosa has a sharply defined sexual maturity size.

Genus *Moseleya*

Table 50. Sexuality and reproduction modes of *Moseleya latistelata*.

Taxon	Sexuality	Reproduction
Moseleya latistellata	Hermaphroditic	Brooder

Genus *Oulastrea* (Zebra Coral)

Table 51. Sexuality and reproduction modes of *Oulastrea crispa*.

Taxon	Sexuality	Reproduction
Oulastrea crispa	Hermaphroditic	Broadcast
Oulastrea crispa	Hermaphroditic	Brooder

Puberty Size of *Oulastrea crispa*

Colonies greater than 20mm in diameter are sexually mature (Lam, 2000).

Genus *Oulophyllia*

Table 52. Sexuality and reproduction modes of *Oulophyllia* species.

Taxon	Sexuality	Reproduction
Oulophyllia bennettae	Hermaphroditic	Broadcast
Oulophyllia crispa	Hermaphroditic	Broadcast

Genus *Parasimplastrea*

There is only one species (*Parasimplastrea sheppardi*). It has a very limited distribution, and no information is available on its reproductive habits.

Genus *Platygyra*

Table 53. Sexuality and reproduction modes of *Platygyra* species.

Taxon	Sexuality	Reproduction
Platygyra contorta	Hermaphroditic	Broadcast
Platygyra daedalea	Hermaphroditic	Broadcast
Platygyra lamellina	Hermaphroditic	Broadcast
Platygyra pini	Hermaphroditic	Broadcast
Platygyra ryukuensis	Hermaphroditic	Broadcast
Platygyra sinensis	Hermaphroditic	Broadcast
Platygyra verweyi	Hermaphroditic	Broadcast

Puberty Age of *Platygyra sinensis*

Platygyra sinensis reaches a reproductive state at ~5 years of age (Babcock, 1991).

Genus *Plesiastrea*

Table 54. Sexuality and reproduction modes of *Plesiastrea verispora*.

Taxon	Sexuality	Reproduction
Plesiastrea verispora		Broadcast

Genus *Solenastrea*

Solenastrea is an Atlantic species (Veron, 1986).

Table 55. Reproduction modes of *Solenastrea* species.

Taxon	Sexuality	Reproduction
Solenastrea boumoni		Broadcast
Solenastrea hyades		Broadcast

Family Flabelliidae

Genus *Flabellum*

Table 56. Sexuality of *Flabellum* species.

Taxon	Sexuality	Reproduction
Flabellum alabastrum (deep water)	Gonochoric	
Flabellum angulare (deep water)	Gonochoric	
Flabellum curvatum (deep water)	Gonochoric	
Flabellum impensum (deep water)	Gonochoric	
Flabellum japonicum	Gonochoric	
Flabellum rubrum	Protandrous Hermaphrodite	
Flabellum rubrum	Hermaphroditic	
Flabellum thouarsii (deep water)	Gonochoric	

Notes on *Flabellum rubrum* Sexuality and Size

Flabellum rubrum - small colonies (13-20mm) are males; larger colonies are hermaphroditic (Gardiner, 1902, in Fadlallah, 1983).

Genus *Gardineria*

Azooxanthellate. No information on reproduction is available.

Figure 28. A female Fungia scutaria spawning at the Hawaii Institute of Marine Biology, Oahu, Hawaii. Note the tiny orange eggs being released. Photo courtesy of Jake Adams.

Genus *Monomyces*

No information on reproduction is available.

Genus *Placotrochus*

No information on reproduction is available.

Family Fungiidae

As a rule, all Fungiids seen to be gonochoric with the exception of one report of *Heliofungia actiniformis* being a brooder.

Genus *Cantharellus*

This Fungiid has a wide geographical range, but is rarely seen. It sometimes lives attached to the substrate (Veron, 2000). No information is available on reproductive habits.

Genus *Ctenactis*

No information is available on reproductive habits.

Genus *Cycloseris*

YouTube has some interesting video clips showing a *Cycloseris* (tentative ID) broadcast spawning. It is tempting to state that *Cycloseris*, like other Fungiids, is a gonochoric broadcast spawner.

Genus *Danafungia*

No information is available on reproductive habits.

Genus *Diaseris*

Table 57. Sexuality and reproduction mode of *Diaseris distorta*.

Taxon	Sexuality	Reproduction
Diaseris distorta	Gonochoric	Broadcast

Puberty Size and Sex Ratios of *Diaseris distorta*

Diaseris distorta (Colley et al., 2000) - Satellite colonies possess sex organs when colony size is ~1 cm^2, while colonies produced sexually do not reach puberty until they are of larger size . Male colonies outnumber females by a ratio of 5 to 1 (in Ecuador).

Genus *Fungia* (Mushroom Coral)

Table 58. Sexuality and Reproduction Modes of *Fungia* species.

Taxon	Sexuality	Reproduction
Fungia actiniformis	See *Heliofungia actiniformis*	
Fungia concinna	Gonochoric	Broadcast
Fungia fungites	Gonochoric	Broadcast
Fungia granulosa	Gonochoric	Broadcast
Fungia horrida		Broadcast
Fungia paumotensis	Gonochoric	Broadcast
Fungia repanda	Gonochoric	Broadcast
Fungia scutaria	Gonochoric	Broadcast
Fungia scutaria	Parthenogenic?	
Fungia sp. (Okinawa)	Gonochoric	Broadcast

Puberty Size, Age and Lifespan of *Fungia* Species

Fungia concinna and *Fungia fungites* are capable of reproduction at 4 years of age (equaling a size of ~6 cm in diameter; Harrison and Wallace, 1990). This information is in good agreement with that of Goffredo and Chadwick-Furman (2004) who report *Fungia scutaria* specimens are approximately 5 years of age when obtaining a diameter of 7 cm.

Further, these researchers report *F. scutaria* specimens are about 14 years old when they obtain a diameter of 22 cm. The estimated life span of *F. scutaria* is about 50 years.

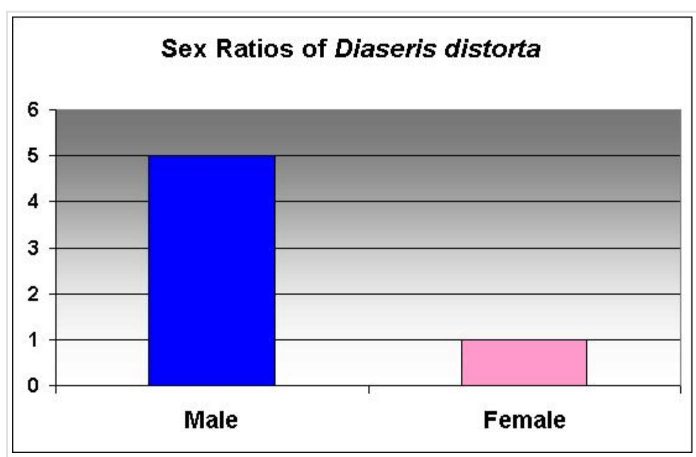

Figure 29. Sex ratios of Diaseris distorta in Galapagos Islands, Ecuador, where there are 5 males to every female colony.

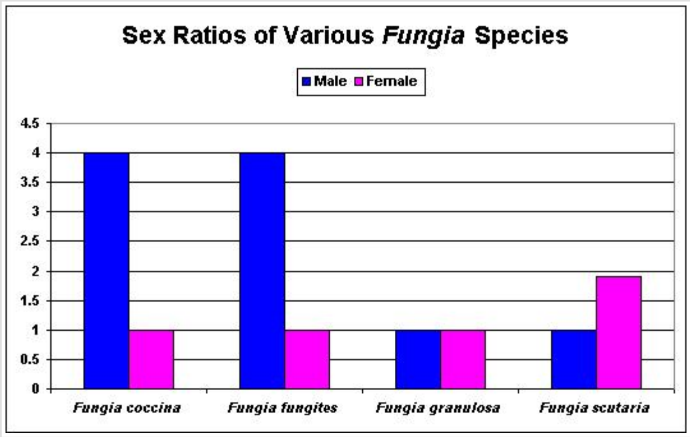

Figure 30. All Fungia species are gonochoric broadcast spawners. Sex ratios vary among species, and then even with environmental conditions. Based on information from Kramarsky-Winter and Loya (1998) and others.

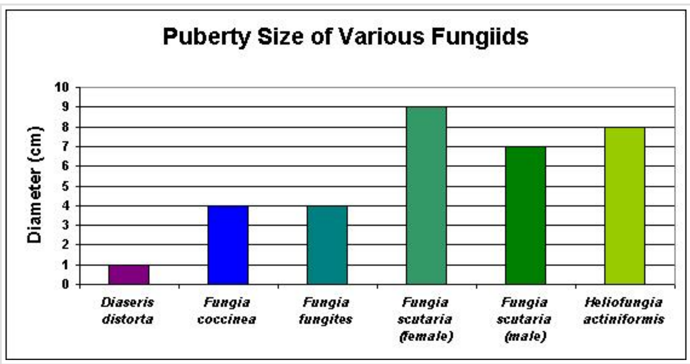

Figure 31. Fungiids can be reproductive over a broad range of sizes.

Table 59. Size at puberty of various Fungiids.

Taxa	Puberty Size	Age	Reference
Fungia coccinea	6 cm diameter	4 years	Harrison & Wallace, 1990
Fungia fungites	6 cm diameter	4 years	Harrison & Wallace, 1990
Fungia grandulosa	5.5 cm diameter	?	Kramarsky-Winter & Loya, 1998
Fungia scutaria (male)	2.5 - 6 cm diameter	?	Kramarsky-Winter & Loya, 1998
Fungia scutaria (female)	>9 cm diameter	?	Kramarsky-Winter & Loya, 1998
Heliofungia actiniformis	8 cm diameter	10 years	Connell, 1973

Genus Fungicyathus

This azooxanthellate coral can live at extreme depths - over 6,000 meters - the deepest of any coral (Veron, 2000). Needles to say, this coral is not likely to be found in your average reef aquarium!

Table 60. Sexuality of *Fungicyathus* species.

Taxon	Sexuality	Reproduction
Fungicyathus crispa	Gonochoric	
Fungicyathus fragilis	Gonochoric	
Fungicyathus marenzelleri	Gonochoric	

Genus Halomitra

No information available.

Genus Heliofungia (Plate Coral)

Table 61. Sexuality and Reproduction Modes of *Heliofungia actiniformis*.

Taxon	Sexuality	Reproduction
Heliofungia actiniformis	Hermaphroditic (?)	Brooder
Heliofungia actiniformis	Gonochoric	Broadcast

Heliofungia Puberty Size and Age

Heliofungia actiniformis is reproductive at 10 years of age with a corresponding diameter of 8cm (Connell, 1973).

Genus Herpetoglossa

Table 62. Sexuality and Reproduction Mode of *Herpetoglossa simplex*.

Taxon	Sexuality	Reproduction
Herpetoglossa simplex	Gonochoric	Broadcast

Genus Herpolitha

Table 63. Sexuality and Reproduction Mode of *Herpolitha limax*.

Taxon	Sexuality	Reproduction
Herpolitha limax	Gonochoric	Broadcast

Genus Lithophyllon

No information available.

Genus Podabacia

Table 64. Sexuality and Reproduction Mode of *Podabacia crustacea*.

Taxon	Sexuality	Reproduction
Podabacia crustacea	Gonochoric	Broadcast

Genus Polyphyllia

Table 65. Sexuality and Reproduction Mode of *Polyphyllia talpina*.

Taxon	Sexuality	Reproduction
Polyphyllia talpina	Gonochoric	Broadcast

Genus *Sandalolitha*

Table 66. Sexuality and Reproduction Mode of *Sandalolitha robusta*.

Taxon	Sexuality	Reproduction
Sandalolitha robusta	Gonochoric	Broadcast

Genus *Verilliofungia*

No information available.

Genus *Zoopilus*

No information available.

Family Meandrinidae

This family has 4 genera found only in the Atlantic. For the purist, the Meandrinidae is sometimes spelled differently from the way it is listed in Veron's *Corals of the World* (2000).

Genus *Ctenella*

No information available on the reproduction habits of the one known species (*C. chagius*) from the western Pacific. This coral has a limited distribution (Veron, 2000).

Genus *Dendrogyra* (Pillar Coral)

Only one known species (*D. cylindrus*), an uncommon coral from the Caribbean.

Table 67. Sexuality and Reproduction Mode of *Dendrogyra cylindrus*.

Taxon	Sexuality	Reproduction
Dendrogyra cylindrus	Gonochoric	Broadcast

Figure 32. This Dendrogyra is reproducing asexually via 'budding' but it is also a gonochoric broadcast spawner. Photo courtesy of Julian Sprung.

Genus *Dichocoenia* (Caribbean Starlet Coral)

Dichocoenia stokesi has been shown to spawn in September and October of each year (Hoke et al., 2002).

Table 68. Sexuality and Reproduction Mode of *Dichocoenia* Species.

Taxon	Sexuality	Reproduction
Dichocoenia stellaris		Brooder
Dichocoenia stokesi	Gonochoric & Hermaphroditic	Broadcast

Genus *Eusmilia* (Flower Coral)

A beautiful Caribbean coral which makes it a rarity in captivity.

Table 69. Reproduction mode of*Eusmilia fastigata.*

Taxon	Sexuality	Reproduction
Eusmilia fastigata		Broadcast

Genus *Gyrosmilia*

Gyrosmilia has a relatively small geographical range and is found only in the West Indian Ocean & Red Sea. No information available on the one species known.

Genus *Meandrina* (Tan Brain Coral)

Table 70. Reproduction Mode of Two *Meandrina* Species.

Taxon	Sexuality	Reproduction
Meandrina areolata	?	Brooder
Meandrina meandrites		Brooder

Genus *Montigyra*

No information available on the one species known.

Family Merulinidae

Veron (1986) reports these corals are hermaphroditic broadcast spawners.

Genus *Boninastrea*

No specific information is available on reproductive habits.

Genus *Hydnophora*

Table 71. Sexuality and Reproduction Modes of Two *Hydnophora* Species.

Taxon	Sexuality	Reproduction
Hydnophora exesa	Hermaphroditic	Broadcast
Hydnophora rigida	Hermaphroditic	Broadcast

Genus *Merulina*

Table 72. Sexuality and Reproduction Modes of Two *Merulina* Species.

Taxon	Sexuality	Reproduction
Merulina ampliata	Hermaphroditic	Broadcast
Merulina scabricula	Hermaphroditic	Broadcast

Genus *Paraclavarina*

Paraclavarina specimens are occasionally seen in the trade. Although usually colored tan, their distinct shape makes them a worthwhile addition to a SPS tank. Table 61 uses the outdated name of *Clavarina*, per Babcock and Heyward's 1986 description.

Table 73. Sexuality and Reproduction Mode of *Paraclavarina (Clavarina) triangulis*.

Taxon	Sexuality	Reproduction
Clavarina triangularis	Hermaphroditic	Broadcast

Genus *Scapophyllia*

Table 74. Reproduction Mode of a *Scapophyllia* Species.

Taxon	Sexuality	Reproduction
Scapophyllia cylindrica	Hermaphroditic	Broadcast

Family Micrabaciidae

Genus *Stephanophyllia*

Table 75. Reproduction Mode of a *Stephanophyllia* Species.

Taxon	Sexuality	Reproduction
Stephanophyllia formosissima		Brooder

Family Mussidae

Genus *Acanthastrea*

Recent imports from Australia's Great Barrier Reef have included a number of spectacular *Acanthastrea* specimens. Their fluorescent pigments are showcased in reef aquaria and, not surprisingly, are popular and command high prices - making them a good candidate for captive propagation efforts.

Figure 33. Imagine a tank full of settled Acanthastrea 'spats'. Photo courtesy of Steve Ruddy.

Table 76. Sexuality and Reproduction Modes of *Acanthastrea* Species.

Taxon	Sexuality	Reproduction
Acanthastrea hillae	Hermaphroditic	Broadcast
Acanthastrea echinata	Hermaphroditic	Broadcast
Acanthastrea lordhowensis	Hermaphroditic	Broadcast

Genus *Micromussa*

Veron (2000) created this genus to distinguish corals containing certain skeletal details from those previously listed as *Acanthastrea*, and states that these corals are rare. His book lists 3 species. To my knowledge, there is spawning information on only one species.

Table 77. Reproduction Mode of a *Micromussa* Species.

Taxon	Sexuality	Reproduction
Micromussa amakuensis		Broadcast

Genus *Mussismilia*

Table 78. Reproduction Mode of *Mussismilia* Species.

Taxon	Sexuality	Reproduction
Mussismilia braziliensis	Hermaphroditic	Broadcast
Mussismilia hartii	Hermaphroditic	Broadcast
Mussismilia hispida	Hermaphroditic	Broadcast
Mussismilia sp.	Hermaphroditic	

Genus *Mussa* (Flower Coral)

Table 79. Sexuality and Reproduction Mode of *Mussa* Species.

Taxon	Sexuality	Reproduction
Mussa sp.	Hermaphroditic	
Mussa angulosa		Brooder

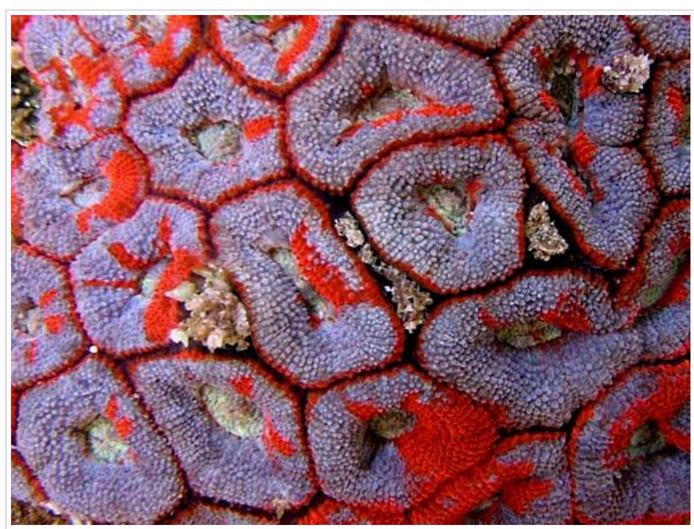

Figure 34. The reproductive habits of Micromussa species have only recently been described. Photo courtesy Jake Adams and www.coralidea.com

Genus *Isophyllia* (Stalked Cactus Coral)

Table 80. Sexuality and Reproduction Modes of *Isophyllia* Species.

Taxon	Sexuality	Reproduction
Isophyllia dipsacea	Gonochoric	Brooder (external)
Isophyllia sinuosa	Gonochoric	Brooder
Isophyllia sp.	Gonochoric (?)	Broadcast

Isophyllia sinuosa Puberty/Adult Colony Size

Adult *I. sinuosa* specimens are about 6 inches in diameter.

Genus *Isophyllastrea* (Rough Star Coral)

Veron (2000) states this coral's proper name as *Isophyllia rigida*, but I have listed it as the Coral Reef Task Force originally described it.

Table 81. Reproduction Mode of *Isophyllastrea/Isophyllia rigida*.

Taxon	Sexuality	Reproduction
Isophyllastrea rigida	?	Brooder

Genus *Mycetophyllia* (Large Cactus Coral)

Table 82. Sexuality and Reproduction Mode of *Mycetophyllia* Species.

Taxon	Sexuality	Reproduction
Mycetophyllia ailiciae	Hermaphroditic	Brooder
Mycetophyllia danaana		Brooder
Mycetophyllia ferox	Hermaphroditic	Brooder
Mycetophyllia lamarckiana		Brooder
Mycetophyllia reesi		Brooder

Genus *Australomussa*

No information available.

Genus *Blastomussa*

No information available.

Genus *Cynarina*

Table 83. Sexuality and Reproduction Mode of *Cynarina lacrymalis*.

Taxon	Sexuality	Reproduction
Cynarina lacrymalis	Hermaphroditic	Broadcast

Genus *Lobophyllia*

Table 84. Sexuality and Reproduction Mode of *Lobophyllia* Species.

Taxon	Sexuality	Reproduction
Lobophyllia corymbosa	Hermaphroditic	Broadcast
Lobophyllia hemprichii	Hermaphroditic	Broadcast
Lobophyllia pachysepta	Hermaphroditic	Broadcast
Lobophyllia sp.	Hermaphroditic	

Genus *Scolymia* (Fungus Coral)

Table 85. Reproduction Mode of *Scolymia* Species.

Taxon	Sexuality	Reproduction
Scolymia sp. (Atlantic)	?	Brooder
Scolymia cubensis	See *Scolymia wellsi*	
Scolymia vitiensis	Hermaphroditic	Broadcast
Scolymia wellsi	Hermaphroditic	Brooder
Scolymia wellsi	Gonochoric (?)	Brooder

Genus *Symphyllia*

Table 86. Sexuality and Reproduction Mode of *Symphyllia* Species.

Taxon	Sexuality	Reproduction
Symphyllia radians	Hermaphroditic	Broadcast
Symphyllia recta	Hermaphroditic	Broadcast
Symphyllia sp.	Hermaphroditic	

Family Oculinidae

Genus *Acrhelia*

This genus was discontinued by Veron (2000), who considers *Acrhelia horrescens* to now be *Galaxea horrescens*. I include this information to avoid confusion.

It does not change the fact that *Galaxea/Acrhelia horrescens* is a brooder (Kawaguti, 1941).

Table 87. Reproduction Mode of *Acrhelia horrescens*.

Taxon	Sexuality	Reproduction
Acrhelia horrescens	?	Brooder

Figure 35. A strikingly beautiful Scolymia specimen. Photo courtesy Jake Adams and www.coralidea.com

Genus *Galaxea* (Galaxy Corals)

Table 88. Sexuality and Reproduction Mode of *Galaxea* Species.

Taxon	Sexuality	Reproduction
Galaxea aspera	?	Brooder
Galaxea astreata	Hermaphroditic	Broadcast
Galaxea fascicularis	Hermaphroditic, female sterile	Broadcast
Galaxea fascicularis	Gonochoric	Broadcast
Galaxea horrescens		Brooder

Genus *Neohelia*

Table 89. Sexuality of *Neohelia porcellania*.

Taxon	Sexuality	Reproduction
Neohelia porcellana	Gonochoric (?)	

Genus *Oculina* (Bush Corals or Ivory Tree Coral)

Table 90. Sexuality and Reproduction Modes of *Oculina* Species.

Taxon	Sexuality	Reproduction
Oculina sp.		Broadcast
Oculina varicosa	Gonochoric	Broadcast
Oculina patagonica	Gonochoric	Broadcast

Oculina varicosa spawns in late summer and early fall. Planula larvae settle at about 21 days of age (Brooke et al., 2002).

Genus *Madepora*

Table 91. Sexuality of a *Madrepora* Species.

Taxon	Sexuality	Reproduction
Madrepora oculata (deep water)	Gonochoric	?

Genus *Schizoculina*

No information available on reproductive habits.

Genus *Simplastrea*

No information available on reproductive habits.

Family Pectiniidae

All corals in Pectiniidae are hermaphroditic broadcast spawners (Veron, 1986).

Genus *Echinomorpha*

Contains one species, *Echinomorpha* (formerly *Echinophyllia*) *nihi-hirai* (Veron, 2000).

Genus *Echinophyllia*

Some *Echinophyllia* species are particularly colorful and command extreme prices. Unfortunately, observations of spawning within aquaria have not been made.

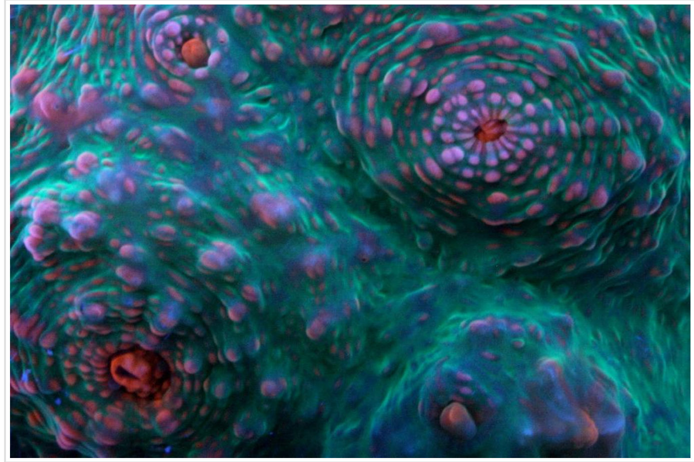

Figure 36. An Echinophyllia species. Photo by the author.

Table 92. Sexuality and Reproduction Modes of *Echinophyllia* Species.

Taxon	Sexuality	Reproduction
Echinophyllia aspera	Hermaphroditic	Broadcast
Echinophyllia orpheensis	Hermaphroditic	Broadcast

Genus *Mycedium*

Table 93. Sexuality and Reproduction Mode of a *Mycedium* Species.

Taxon	Sexuality	Reproduction
Mycedium elephantotus	Hermaphroditic	Broadcast

Genus *Oxypora*

Table 94. Sexuality and Reproduction Modes of Two *Oxypora* Species.

Taxon	Sexuality	Reproduction
Oxypora glabra	Hermaphroditic	Broadcast
Oxypora lacera	Hermaphroditic	Broadcast

Genus *Pectinia*

Table 95. Sexuality and Reproduction Modes of *Pectinia* Species.

Taxon	Sexuality	Reproduction
Pectinia alcicornis	Hermaphroditic	Broadcast
Pectinia lactuca	Hermaphroditic	Broadcast
Pectinia paeonia	Hermaphroditic	Broadcast

Family Pocilloporidae

Family Pocilloporidae contains 3 genera - *Pocillopora*, *Seriatopora* and *Stylophora*.

Figure 37. Pocillopora eydouxi is a hermaphroditic broadcast spawner. Kauai, Hawaii. Photo by the author.

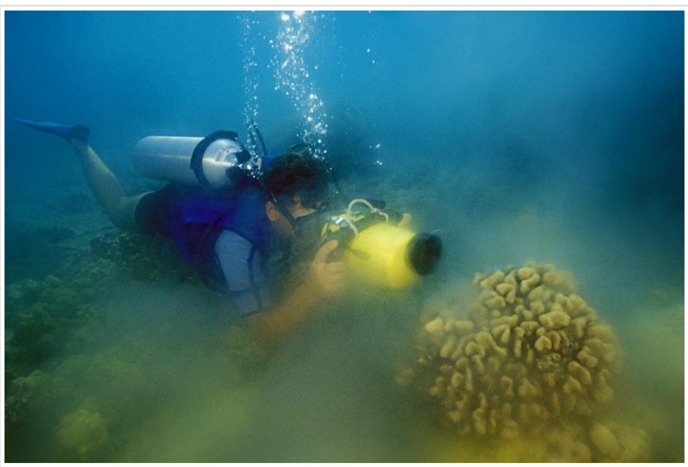

Figure 38. In this photo by David Kearnes, the normally clear waters off Kailua-Kona, Hawaii become cloudy with gametes during the seasonal Pocillopora meandrina spawnings.

Genus *Pocillopora* (Wart Corals)

Table 96. Sexuality and Reproduction Mode of *Pocillopora* Species.

Taxon	Sexuality	Reproduction
Pocillopora bulbosa	See *P. damicornis*	Brooder
Pocillopora brevicornis	See *P. damicornis*	
Pocillopora caespitosa	See *P. damicornis*	Brooder
Pocillopora damicornis	Hermaphroditic	Brooder
Pocillopora damicornis	Parthenogenic?	
Pocillopora damicornis		Broadcast
Pocillopora damicornis Type Y		Brooder
Pocillopora damicornis Type B		Brooder
Pocillopora elegans	?	Brooder
Pocillopora eydouxi	Hermaphroditic	Broadcast
Pocillopora meandrina	Hermaphroditic	Broadcast
Pocillopora verrucosa	Hermaphroditic	Broadcast
Pocillopora verrucosa	?	Broadcast

Puberty Sizes of Two *Pocillopora* Species

Pocillopora damicornis is probably the most researched species of any stony coral.

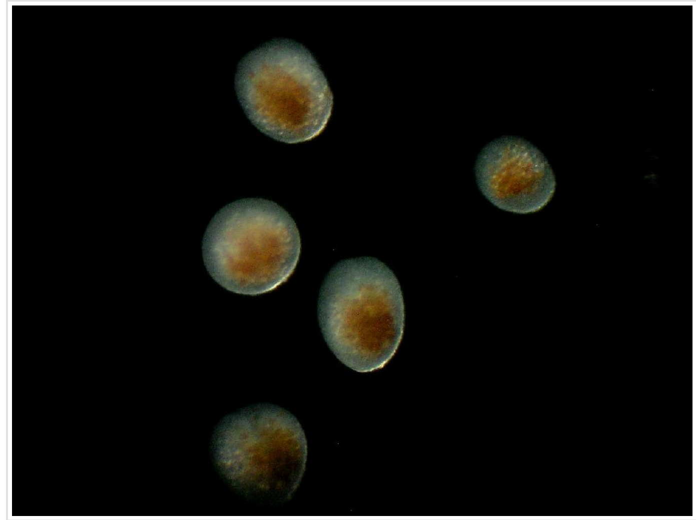

Figure 39. Within hours, the water will swarm with billions of planula larvae. Only a few will survive long enough to settle. Photomicrograph by the author.

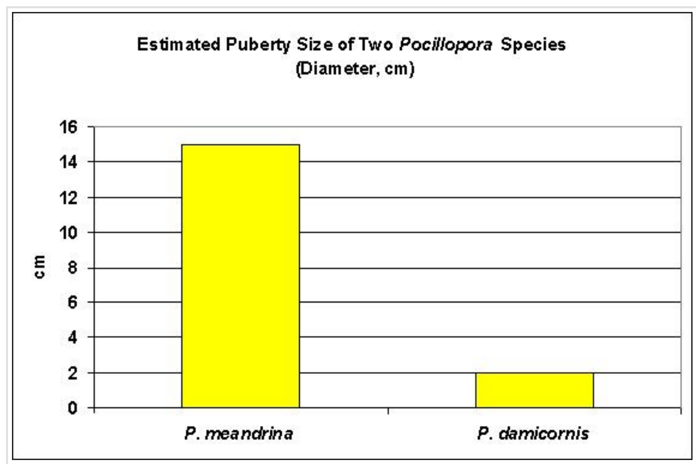

Figure 40. Again, this figure demonstrates that a brooder (P. damicornis) is reproductive at a smaller size than the broadcast spawner (P. meandrina).

Jokiel (1997) states that Pocillopora *damicornis* at a size of 10 cm (~4") diameter releases 220 planula larvae per month. Harrigan (1972) found *P. damicornis* as small as 5 cm in diameter can produce planulae (estimated to be 1-2 years old).

Ricmond (in Richmond and Hunter, 1990) states *Pocillopora damicornis* takes at least two years to mature. *P. damicornis* colonies in the eastern Pacific can live to at least 70 years of age (Richmond & Hunter, 1990).

During the 2008 *Pocillopora meandrina* mass spawning in Hawaii, the smallest colony observed spawning was ~6" in diameter (personal observations), which is about 2" less in diameter than the smallest mature colony observed by Stimson (1978).

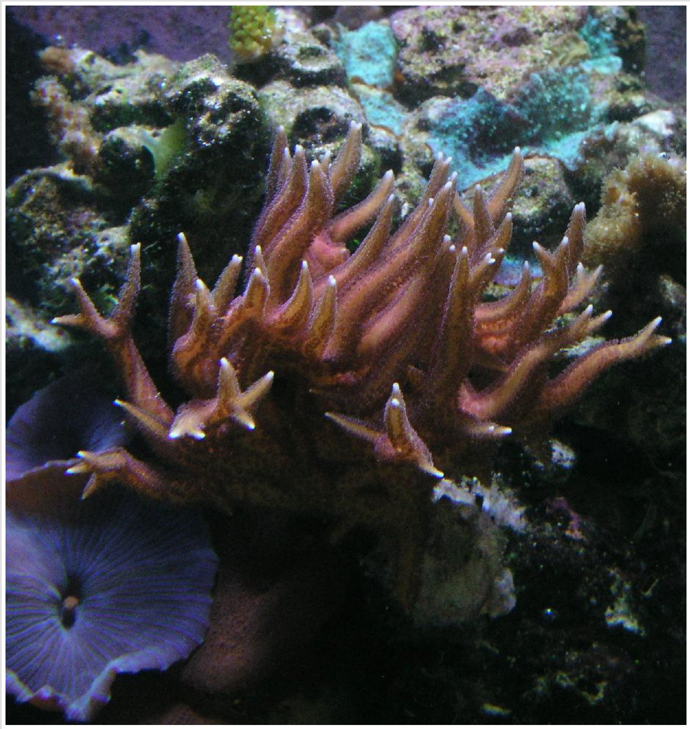

Figure 41. The red morph of Seriatopora hystrix. It is a hermaphroditic brooder, making it a prime candidate for aquarium spawning, yet reports of reproduction in captivity are practically non-existent. Why? (This photo was taken during a recent visit to Salt Lake City. If this is your coral, please contact me and I'll post a tardy photo credit).

Genus *Seriatopora* (Bird's Nest Corals)

Table 97. Sexuality and Reproduction Mode of *Seriatopora* Species.

Taxon	Sexuality	Reproduction
Seriatopora caliendrum	Hermpahroditic	Brooder
Seriatopora hystrix	Hermaphroditic	Brooder

Genus *Stylophora* (Club Coral)

Table 98. Sexuality and Reproduction Mode of *Stylophora* Species.

Taxon	Sexuality	Reproduction
Stylophora mordax		Brooder
Stylophora pistillata	Hermaphroditic	Brooder
Stylophora pistillata	Protandrous Hermaphrodite	

Notes on *Stylophora pistillata* Sexuality

Stylophora pistillata is a male in its first year and then becomes hermaphroditic, capable of self-fertilization and brooding in its second year (Loya, 1976). Later, Rinkevich and Loya stated that *Stylophora pistillata* reaches puberty at 1.5 to 2 years of age.

Family Poritidae

Genus *Alveopora*

Table 99. Sexuality and Reproduction Mode of *Alveopora* Species.

Taxon	Sexuality	Reproduction
Alveopora daedalea	Hermaphroditic	Brooder
Alveopora japonica	Hermaphroditic	Brooder

Genus *Goniopora* (Flower Pot Corals)

Table 100. Sexuality and Reproduction Mode of *Goniopora* Species.

Taxon	Sexuality	Reproduction
Goniopora columna	Gonochoric	Broadcast
Goniopora dijboutiensis	Gonochoric	Broadcast
Goniopora fruticosa	Possibly sterile	
Goniopora gigas	?	Broadcast
Goniopora lobata	Gonochoric	Broadcast
Goniopora minor	Gonochoric	Broadcast
Goniopora norfolkensis	Gonochoric	Broadcast
Goniopora palauensis		Broadcast
Goniopora queenslandiae	Gonochoric	Brooder
Goniopora savignyi	Gonochoric	Broadcast
Goniopora sp.	Gonochoric	Broadcast
Goniopora sp. 1	Gonochoric	Broadcast
Goniopora tenuidens	Gonochoric	Broadcast

Genus *Porites* (Lobe and Finger Corals)

Notes on *Porites* Puberty Size and Sex Ratios

Porites andrewsi: 2:1 male/female, with a small percentage (~4%) being hermaphroditic.

Porites astreoides: A Caribbean coral, and within specimens containing gonads - some do not!) are found in percentages of 48% hermaphroditic to 52% female, giving a ratio, of course, ~1 to 1 (Chornesky and Peters, 1987). McGuire (1998) states that *Porites astreoides* capable of reproduction at 70 cm^2 (approx. 14" square).

Porites lobata: Spawning ratios were 1:1 in Hawaii (Mate, 1997); ~1:1 at the Great Barrier Reef, Australia (Kojis and Quinn, 1981) and 1:1 in the eastern Pacific (but 14% of Costa Rican *P. lobata* colonies were hermaphroditic - Glynn et al., 1994).

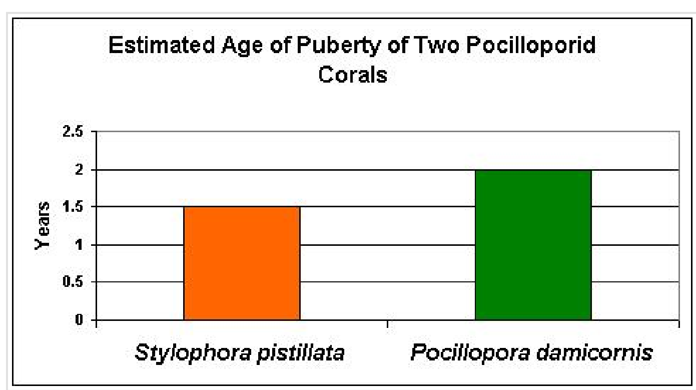

Figure 42. These two brooding corals mature relatively quickly.

Table 101. Sexuality and Reproduction Mode of *Porites* Species.

Taxon	Sexuality	Reproduction
Porites andrewsi	Gonochoric	Broadcast
Porites annae		Broadcast
Porites astreoides	Hermaphroditic	Brooder
Porites astreoides	Hermaphroditic & Female	Brooder
Porites astreoides	Hermaphrodite & Female/ Male	Brooder
Porites attenuata		Brooder
Porites australensis	Gonochoric	Broadcast
Porites branneri		Brooder
Porites brighami	Gonochoric or Hermaphroditic	Brooder
Porites clavaria	Gonochoric	Brooder
Porites colonensis		Brooder
Porites compressa	Gonochoric	Broadcast
Porites cylindrica	Gonochoric	Broadcast
Porites divaricata		Brooder
Porites evermanni	Gonochoric	Broadcast
Porites furcata	Gonochoric	Brooder
Porites haddoni	see *Porites stephensoni*	Brooder
Porites heronensis		Brooder
Porites lichen	Hermaphroditic	Brooder
Porites lobata	Gonochoric	Broadcast
Porites lobata	Parthenogenic?	
Porites lutea	Gonochoric	Broadcast
Porites lutea	Parthenogenic?	
Porites murrayensis	Gonochoric	Brooder
Porites panamensis	Gonochoric	Brooder
Porites porites	Gonochoric	Brooder
Porites porites	Hermaphroditic	
Porites rus	Gonochoric	?
Porites solida	Gonochoric	Broadcast
Porites stephensoni	?	Brooder

Porites lutea: Roughly 1:1 at the Great Barrier Reef, Australia (Kojis and Quinn, 1981).

Harriot (1983) estimates *Porites lutea* reaches puberty at 4 years of age.

Porites murrayensis: Reproductive at 1.3 - 5.5 cm diameter (adult colonies are <20 cm in diameter) at Australia's Great Barrier Reef (Kojis and Quinn, 1981)

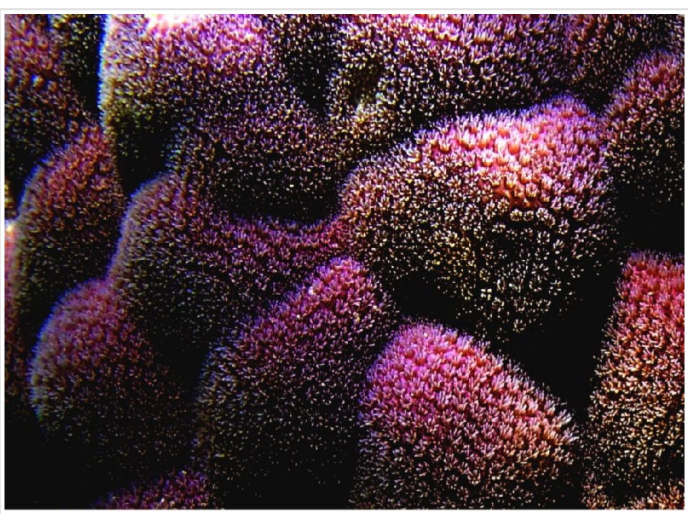

Figure 43. A Porites lutea, from a shallow tide pool in Keauhou, Hawaii. Photo by the author.

Genus *Poritipora*

This genus, erected by Veron, 2000, has a limited distribution from the east coast of Africa and northeast to the Indian coast and nothing is known of its reproductive habits.

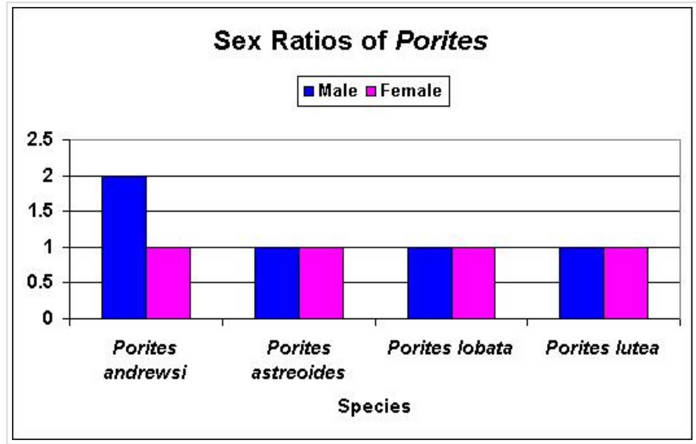

Figure 44. Sex ratios of various Porites species.

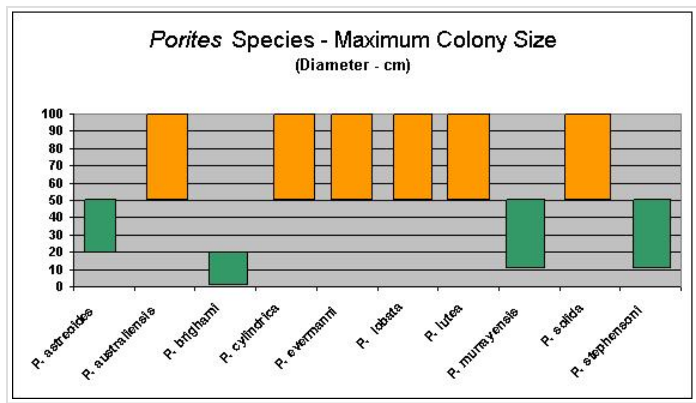

Figure 45. Brooders are in green, Broadcasters in orange. Note that adult size of brooders is always smaller that broadcasting species. Also note that 100 cm diameter may not be the largest possible colony size, it is the uppermost category listed by the researcher (Soong, 1993). For true maximum colony sizes of Porites lobata and P. lutea, see Figure 45. Note that P. brighami is endemic to Hawaii.

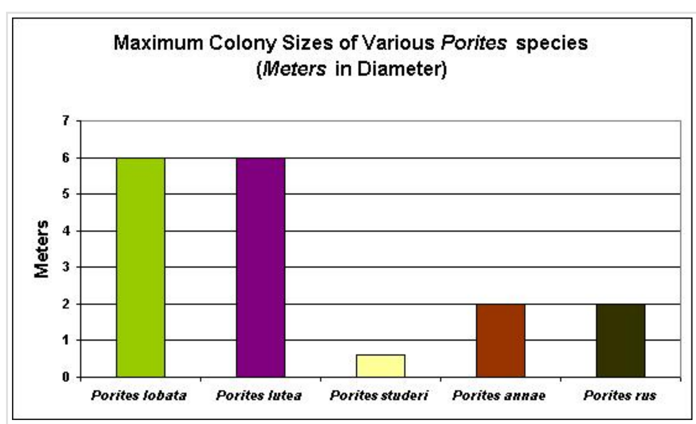

Figure 46. True maximum colony size of various Porites species. Information from Doug Fenner, 2005.

Genus *Stylaraea*

This genus contains but one species (*S. punctata*), and it is small (<15mm across). We could expect its reproductive size to be very small. It refers carbonate biofilms for settlement (Golbuu & Richmond, 2007). Information is available for *S. punctata*, but I lost the reference and am supremely disappointed that I cannot find that information in a stack of over 500 reference papers.

Subgenus *Synaraea*

Controversy about the validity of subgenus *Synaraea* exists (Veron 2000 lists *Porites* (*Synaraea*) *rus* as simply *P. rus*, but acknowledges the previous classification).

Table 102. Sexuality of *Porites* (Subgenus*Synaraea) rus.*

Taxon	Sexuality	Reproduction
Porites rus	Gonochoric	?

Family Rhizangiidae

Genus *Astrangia*

Table 103. Sexuality and Reproduction Modes of *Astrangia* Species.

Taxon	Sexuality	Reproduction
Astrangia danae	Gonochoric	Broadcast
Astrangia lajollaensis	Gonochoric	Broadcast
Astrangia poculata	See *A. danae*	

Genus *Culicia*

No information available on this corals' reproductive habits.

Family Siderastreidae

Many studies have been conducted on *Siderastrea* species from the Atlantic, some of which is listed here.

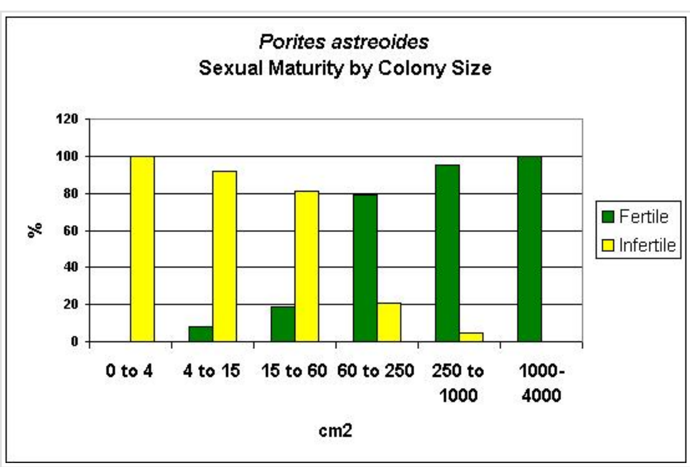

Figure 47. Size of adult colonies of the Atlantic coral Porites astreoides. It is a brooder.

Genus *Anomastraea*

No information available on this corals' reproductive habits.

Genus *Coscinaraea*

Table 104. Sexuality and Reproduction Mode of *Coscinarea columna*.

Taxon	Sexuality	Reproduction
Coscinarea columna	Gonochoric	Broadcast

Genus *Horastrea*

No information available on this coral's reproductive habits.

Genus *Psammocora*

Table 105. Sexuality and Reproduction Mode of *Psammocora* species.

Taxon	Sexuality	Reproduction
Psammocora contigua	Gonochoric	Broadcast
Psammocora digitata	Gonochoric	Broadcast
Psammocora stellata	?	Brooder

Genus *Pseudosiderastrea*

No reproductive information available.

Genus *Siderastrea* (Starlet Corals)

Legally-collected Caribbean *Siderastrea* colonies (*S. siderea*, *S. stellata* or *S. radians*) may be available in the future (Michael Janes, personal communication). *S. radians* is relatively small, and generally considered to be a brooder, making it an excellent candidate for captive propagation efforts.

Table 106. Sexuality and Reproduction Mode of *Siderastrea* species.

Taxon	Sexuality	Reproduction
Siderastrea radians	Gonochoric	Brooder
Siderastrea radians	Hermaphroditic	Brooder
Siderastrea radians	Protandrous Hermaphrodite	
Siderastrea siderea		Brooder
Siderastrea siderea	Gonochoric	Broadcast
Siderastrea stellata		Brooder

Sex Ratios of *Siderastrea radians*

Siderastrea radians is found in male/female ratios of 1:1. (Lazar, internet resource, date unknown).

Table 107. Puberty Size and Age Data for *Siderastrea* Species.

Taxa	Puberty Size	Age	Reference
Siderastrea radians	2- 4 cm^2	1.5 - 2 years	Soong, 1992
Siderastrea siderea	>100 cm^2	7-9 years	Soong, 1992

Comments on *Siderastrea* Reproduction and Longevity

Siderastrea radians is a protogynous hermaphrodite (Duerden, 1902, in Fadlallah, 1983).

Elahi and Edmunds (2007) report that *Siderastrea siderea* colonies can be at least 125 years old (based on a growth rate of 4mm (~1/6") per year). *Siderastrea siderea* juveniles are less than 40mm in diameter, and mature colonies are 5.9 - 11.4 cm in diameter.

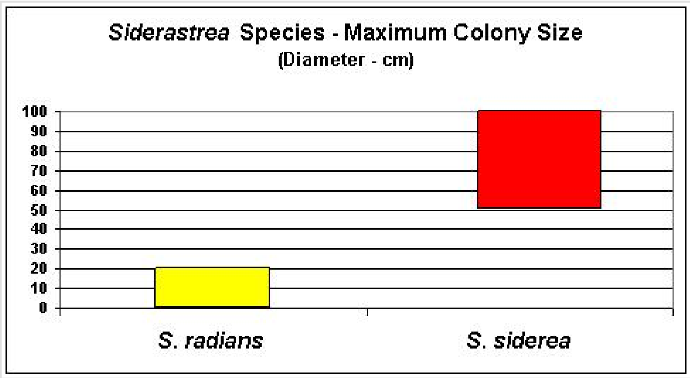

Figure 48. Siderastrea sizes - note that 100 cm diameter may not be the largest colony size, it is the largest category (50-100 cm) listed by the researcher (Soong, 1993).

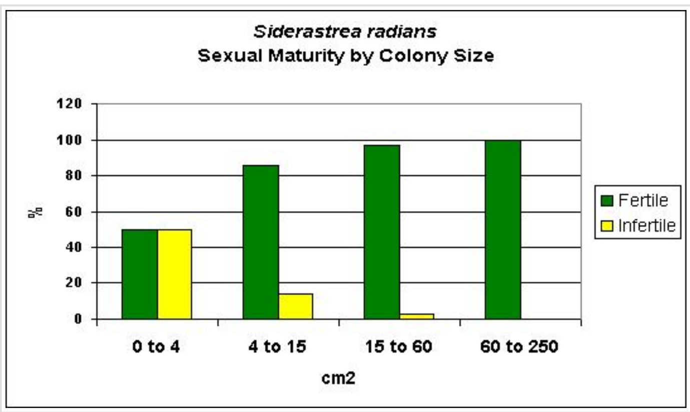

Figure 49. Colony size and its relationship to sexual maturity of Siderastrea radians.

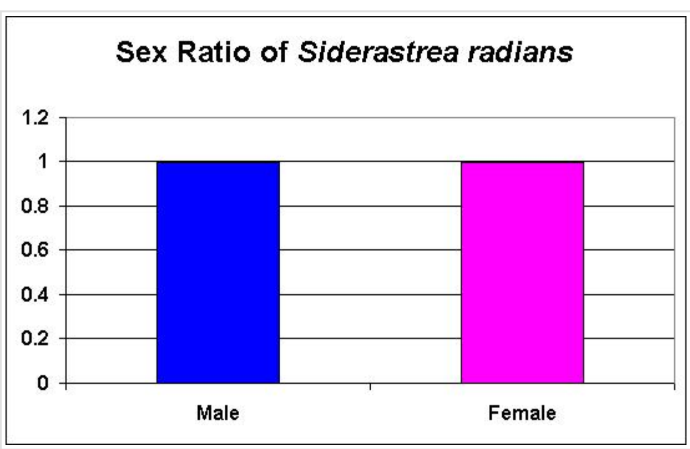

Figure 50. Males and females are found evenly in this case. It could be different in other areas due to any number of factors, but this has yet to be demonstrated for this coral species.

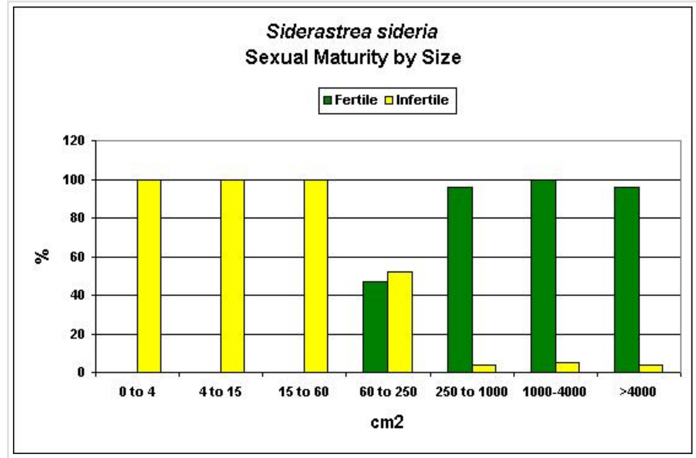

Figure 51. Siderastrea species have been carefully studied by a number of researchers, resulting in information such as this.

Family Trachyphylliidae

Genus *Trachyphyllia*

There are limited reports of this coral broadcast spawning in aquaria (Tyree, 1994).

In Closing

As a matter of convenience (mostly mine), I have chosen to publish the reference list at the close of this series. If you like a copy earlier, please email me (RiddleLabs@aol.com) and I'll send this information in a Word document.

Next time, we'll examine the reproduction habits of soft corals.

Acknowledgements

It would have been much easier to simply list the reproductive information of various stony corals. In fact, the initial draft of this article contained few photos. I felt this made the article a little too dry, so, I went, with hat in hand, to many sources asking for help - and thankfully a number of hobbyists and professional aquarists responded. Many thanks go to Dr. Bruce Carlson (once at the Waikiki Aquarium, but now at the Georgia Aquarium), Mitch (the King) Carl of the Henry Doorly Zoo, Omaha, Nebraska, Jake Adams (www.coralidea.com), Steve Ruddy (www.coralreefecosystems.com), Julian Sprung (www.twolittlefishies.com), master aquarist Tony Vargas, Michael P. Janes (www.aquatouch.com), and all the hobbyists across the country who extended a warm welcome to their homes and allowed me to take measurements and photographs.

Coral Spawning Observation Sheet

Date: ______________________

Time: ________________

Coral species: ___________________________________

Length of Time in Captivity: ____________________________

Sexuality (check all that apply):

Gonochoric (eggs or sperm only): _____

Hermaphroditic: ______

Vigorous Ejection of Eggs and/or Sperm: ______

Slow Extrusion of Eggs and/or Sperm: ______

Spawning Lasted (hours/minutes): ______

Eggs Sink or Float (circle one)

Egg/Sperm Bundles Sink or Float (circle one)

Reproductive Mode (check one):

Broadcast Spawner: ______

Brooder (internal): ______

Brooder (surface): ______

Effects on Aquarium Water Chemistry (check all that apply):

pH _____ Dissolved Oxygen ______ ORP ______

Environmental Parameters

Photoperiod (hours): ______

Natural Light ______ Artificial Light: ______ Both: ______

Moonlight (natural) ______

Moonlight (artificial) ______

Moonlight (none) ______

Temperature: ______

pH: ______

Comments: ____

____

____

____

____

____

Figure 52. Suggested records for those observing a coral spawning.

Table 108. Quick and Easy Reference Table

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Acanthastrea hillae	Hermaphroditic	Broadcast			Babcock et al., 1986
Acanthastrea echinata	Hermaphroditic	Broadcast			Bermas et al., 1992
Acanthastrea lordhowensis	Hermaphroditic	Broadcast			Wilson & Harrison, 1997
Acrhelia horrescens	?	Brooder			Kawaguti, 1941
Acropora (Isopora) brueggemanni	Hermaphroditic	Brooder			Okubo et al., 2007
Acropora (Isopora) cuneata	Hermaphroditic	Brooder			Bothwell, 1981
Acropora (Isopora) palifera	Hermaphroditic	Brooder			Bothwell, 1981
Acropora (Isopora) togianensis	Hermaphroditic	Brooder			Wallace et al., 2007
Acropora aculeus	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora acuminata		Broadcast			Rosser & Gilmour, in press
Acropora anthoceris	Hermaphroditic	Broadcast		see van Oppen	Babcock et al., 1986
Acropora aspera	Hermaphroditic	Broadcast			Bothwell, 1981
Acropora austera	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora caroliniana		Broadcast			Baird et al., 2000
Acropora cerealis	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora cervicornis	Hermaphroditic	Broadcast			Vargas-Ángel & Thomas, 2002
Acropora clathrata	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora corymbosa	Hermaphroditic	Brooder			Stimson, 1978
Acropora cytheria	Hermaphroditic	Broadcast			Wallace et al., 2007
Acropora danai	Hermaphroditic	Broadcast			Dai et al., 1992; Hayashibara et al.,1993
Acropora delicatula	Possibly sterile				Richmond & Hunter, 1990
Acropora delicatula	See *Acropora selago*	Broadcast			Wallace et al., 2007
Acropora digitifera	Hermaphroditic	Broadcast			Wallace et al., 2007
Acropora dilitata	Hermaphroditic	Broadcast			Heyward, 1985
Acropora divaricata	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora donei	Hermaphroditic	Broadcast			Guest et al., 2005; Hayashibara et al.,1993
Acropora elseyi		Broadcast			Marquis et al., 2005
Acropora eurystoma	Hermaphroditic	Broadcast			Shlesinger & Loya, 1985
Acropora exquisita	Hermaphroditic	Broadcast			Hayashibara et al.,1993
Acropora florida	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora formosa	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora gemmifera	Hermaphroditic	Broadcast			Morita et al., 2006
Acropora glauca	?	Broadcast			Babcock et al., 1986
Acropora grandis	Hermaphroditic	Broadcast			Guest et al., 2002; Babcock et al., 1986
Acropora grandulosa	Hermaphroditic	Broadcast			Wallace, 1985
Acropora hemprichii	Hermaphroditic	Broadcast			Rinkevich and Loya, 1979
Acropora horrida	Hermaphroditic	Broadcast			Wallace, 1985
Acropora humilis	Hermaphroditic	Broadcast			Bothwell, 1981
Acropora humilis	?	Brooder			Stimson, 1978
Acropora hyacinthus	Hermaphroditic	Broadcast			Wallace et al., 2007
Acropora hystrix	Hermaphroditic	Broadcast			Heyward, 1989
Acropora intermeda		Broadcast		X	Guest et al., 2005
Acropora irregularis	Hermaphroditic	Broadcast			Heyward, 1989; Richmond & Hunter, 1990
Acropora jacquelineae		Broadcast			Baird et al., 2000
Acropora kimbeensis					Baird et al., 2000
Acropora "kosurini-like"		Broadcast			Rosser & Gilmour, in press
Acropora latistella	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora lianae		Broadcast			Guest et al., 2005
Acropora listeri		Broadcast			Harrison et al., 1984
Acropora longicyathus	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora loripes	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora lutkeni	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora microclados	Hermaphroditic	Broadcast			Guest et al., 2005; Hayashibara et al.,1993
Acropora microphthalma	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora millepora	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora monticulosa	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora muricata	Hermaphroditic	Broadcast			Wallace et al., 2007
Acropora nana	Hermaphroditic	Broadcast			Dai et al., 1992

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Acropora nastua	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora nobilis	Hermaphroditic	Broadcast			Babcock et al., 198
Acropora ocellata	Hermaphroditic	Broadcast			Kenyan, 1992
Acropora palawensis	?	Brooder			Kawaguti, 1940 in Fadlallah, 1983
Acropora palmata	Hermaphroditic	Broadcast			Miller et al., 2000
Acropora palmerae		Broadcast			Dai et al., 1992
Acropora papillare		Broadcast			Rosser & Gilmour, in press
Acropora plumosa		Broadcast			Baird et al., 2000
Acropora polystoma		Broadcast			Rosser & Gilmour, in press
Acropora pulchra	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora robusta	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora samoensis	Hermaphroditic	Broadcast			Guest et al., 2005; Hayashibara et al.,1993
Acropora sarmentosa	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora scandens	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora secale	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora selago	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora smithi	Hermaphroditic	Broadcast			Richmond & Hunter, 1990
Acropora solitaryensis	Hermaphroditic	Broadcast			Harrison, 2008
Acropora spathulata		Broadcast			Baird et al., 2000
Acropora spicifera		Broadcast			Dai et al., 1992
Acropora squarrosa	Hermaphroditic	Broadcast			Kenyon, 1992
Acropora striata	?	Brooder			Stimson, 1978
Acropora subulata		Broadcast			Rosser & Gimour, in press
Acropora surculosa	Hermaphroditic	Broadcast			Kenyon, 1992
Acropora tenuis	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora tortuosa	Hermaphroditic	Broadcast			Harrison, 2008
Acropora valenciennesi	Hermaphroditic	Broadcast			Hayashibara et al.,1993
Acropora valida	Hermaphroditic	Broadcast			Babcock et al., 1986
Acropora variabilis	Hermaproditic	Broadcast			Shlesinger et al., 1998
Acropora vaughani		Broadcast			Rosser & Gimour, in press
Acropora verweyi	Hermaphroditic	Broadcast			Guest et al., 2005; Hayashibara et al.,1993
Acropora willisae		Broadcast			Negri et al., 2001
Acropora yongei	Hermaphroditic	Broadcast			Babcock et al., 1986
Agaricia agaricites	Hermaphroditic	Brooder			Gleason et al., 2001
Agaricia crassa	?	Brooder			Vaughan, 1908; in Fadlallah, 1983
Agaricia fragilis	?	Brooder			Mayor, 1915; in Fadlallah, 1983
Agaricia grahame	?	Brooder			NOAA Data base
Agaricia humilis	Hermaphroditic	Brooder			van Moorsel, 1980
Agaricia lamarcki	?	Brooder			NOAA Data base
Agaricia purpurea	Hermaphroditic	Brooder			van Moorsel, 1980
Agaricia tenufolia	?	Brooder			NOAA Data base
Agaricia undata	?	Brooder			NOAA Data base
Alveopora daedalea	Hermaphroditic	Brooder			Shlesinger et al., 1998
Alveopora japonica	Hermaphroditic	Brooder			Igarashi et al., 1992
Anacropora matthai		Broadcast			Wallace et al., 2007
Astrangia danae	Gonochoric	Broadcast			Szmant-Froelich et al., 1980
Astrangia lajollaensis	Gonochoric	Broadcast			Fadlallah, 1982
Astrangia poculata	See *A. danae*				Fitzgerlad & Szmant, 1997
Astreopora gracilis		Broadcast			Dai et al., 1992
Astreopora listeri		Broadcast			Dai et al., 1992
Astreopora myriophthalma	Hermaproditic	Broadcast			Shlesinger et al., 1998
Astreopora randalli	Hermaproditic	Broadcast			Richmond & Hunter, 1990
Australogyra zelli	Hermaphroditic	Broadcast			Babcock et al., 1986
Balanophyllia elegans	Gonochoric	Brooder			Fadlallah & Pearse, 1982
Balanophyllia europaea	Hermaphroditic	Brooder			Goffredo et al., 2005
Balanophyllia pruvoti	Gonochoric				Radetic et al., 2002
Balanophyllia regia	Gonochoric (?)	Brooder			Goffredo et al., 2005
Balanophyllia sp.		Brooder			Abe, 1937, in Fadlallah, 1983
Barabattoia amicorum	Hermaphroditic	Broadcast			Babcock et al., 1986
Catalaphyllia jarderni	Gonochoric	Broadcast			Willis et al., 1995
Caulastrea furcata	Hermaphroditic	Broadcast			Babcock et al., 1986
Cladocora caespitosa	Hermaphroditic	Broadcast			Kružić et al., 2008

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Cladopsammia rolandi	Hermaphroditic	Brooder			de Lacaze-Duthiers, 1897, in Fadlallah, 1983
Clavarina triangularis	Hermaphroditic	Broadcast			Babcock & Heyward, 1986; Babcock et al., 1986
Colpophyllia amaranthus		Broadcast			NOAA Database
Colpophyllia breviseralis		Broadcast			NOAA Database
Colpophyllia natans	Hermaphroditic	Broadcast			NOAA Database
Coscinarea columna	Gonochoric	Broadcast			Babcock et al., 1986
Cynarina lacrymalis	Hermaphroditic	Broadcast			Shlesinger et al., 1998
Cyphastrea chalcidicum	Hermaphroditic	Broadcast			Dai et al., 1992; Babcock et al., 1986
Cyphastrea microphthalma	Hermaphroditic	Broadcast			Shlesinger et al., 1998
Cyphastrea ocellina	Hermaphroditic	Brooder			Stimson, 1978; Kolinski & Cox, 2003
Cyphastrea seraila	Hermaphroditic	Broadcast			Wilson, 1997; Hayashibara et al.,1993
Dendrogyra cylindrus	Gonochoric	Broadcast			Szmant, 1986
Dendrophyllia nigrescens	See *Tubastraea spp.*				
Dendrophyllia sp.	Gonochoric	Brooder			Babcock et al., 1986
Diaseris distorta	Gonochoric	Broadcast			Colley et al., 2000
Dichocoenia stellaris		Brooder			NOAA Data base
Dichocoenia stokesi	Gonochoric & Hermaphroditic	Broadcast			Hoke et al., 2002
Diploastrea heliopora	Gonochoric	Broadcast			Hayashibara et al.,1993
Diploria clivosa	Hermaphroditic	Broadcast			Alvarado et al., 2003; NOAA Data base
Diploria labyrinthiformis	Hermaphroditic	Broadcast			Alvarado et al., 2003
Diploria labyrinthiformis	Hermaphroditic	Brooder			Duerden, 1902 in Fadlallah, 1983
Diploria strigosa	Hermaphroditic	Broadcast			Alvarado et al., 2003
Diploria strigosa	Hermaphroditic	Brooder			Hagman et al., 1998
Echinophyllia aspera	Hermaphroditic	Broadcast			Dai et al., 1992; Fan & Dai, 1992
Echinophyllia orpheensis	Hermaphroditic	Broadcast			Babcock et al., 1986
Echinopora gemmacea	Hermaphroditic	Broadcast			Babcock & Heyward, 1986
Echinopora horrida	Hermaphroditic	Broadcast			Babcock et al., 1986
Echinopora lamellosa	Hermaphroditic	Broadcast			Babcock et al., 1986
Echinopora pacificus	Hermaphroditic	Broadcast			Hayashibara et al.,1993
Enallopsammia rostrata(deep water)	Gonochoric				Waller, 2005
Euphyllia ancora	Gonochoric	Broadcast			Willis et al., 1985
Euphyllia divisa	Gonochoric	Broadcast			Babcock et al., 1986
Euphyllia glabrescens	Hermaphroditic	Brooder			Huang et al., 2008
Euphyllia parancora	Gonochoric?	Broadcast			ASIRA Data base
Euphyllia rugosa		Brooder			ASIRA Data base
Eusmilia fastigata		Broadcast			Coral Reef Task Force Data base
Favia bennettae	Hermaphroditic	Broadcast			Babcock et al., 1986
Favia doreyensis	Hermaphroditic	Broadcast			Marshall & Stephenson, 1933, in Fadlallah, 1983
Favia favus	Hermaphroditic	Broadcast			Shlesinger et al., 1998
Favia favus	Gonochoric	Broadcast			Alvarado et al., 2003
Favia favus	Hermaphroditic	Broadcast			Hayashibara et al.,1993
Favia fragum	Hermaphroditic	Brooder			Alvarado et al., 2003
Favia helianthoides	Hermaphroditic	Broadcast			Bermas et al., 1992
Favia laxa		Broadcast			Dai et al., 1992
Favia lizardensis	Hermaphroditic	Broadcast			Babcock et al., 1986
Favia matthai	Hermaphroditic	Broadcast			Babcock et al., 1986
Favia pallida	Hermaphroditic	Broadcast			Penland et al., 2004; Babcock & Hey ward,1986
Favia rotumana		Broadcast			Harrison et al., 1984
Favia speciosa	Hermaphroditic	Broadcast			Penland et al., 2004; Dai et al, 1992
Favia stelligera	Hermaphroditic	Broadcast			Babcock et al., 1986
Favia veroni	Hermaphroditic	Broadcast			Babcock et al., 1986
Favites abdita	Hermaphroditic	Broadcast			Penland et al., 2004; Wallace et al., 2007
Favites bennettae	Hermaphroditic	Broadcast			Babcock et al., 1986
Favites chinensis	Hermaphroditic	Broadcast			Nowzawa & Harrison, 2005
Favites complanata	Hermaphroditic	Broadcast			Babcock & Heyward, 1986
Favites flexuosa	Hermaphroditic	Broadcast			Babcock et al., 1986
Favites halicora	Hermaphroditic	Broadcast			Penland et al., 2004; Babcock et al., 1986
Favites pentagona	Hermaphroditic	Broadcast			Oliver and Babcock, 1992

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Favites russelli	Hermaphroditic	Broadcast			Dai et al., 1992; Babcock et al., 1986
Flabellum alabastrum (deep water)	Gonochoric				Fadlallah, 1983
Flabellum angulare (deep water)	Gonochoric				Waller, 2005
Flabellum curvatum (deep water)	Gonochoric				Waller, 2005
Flabellum impensum (deep water)	Gonochoric				Waller, 2005
Flabellum japonicum	Gonochoric				Fadlallah, 1983
Flabellum rubrum	Protandrous Hermaphrodite				Moseley, 1881, in Fadlallah, 1983
Flabellum rubrum	Hermaphroditic				Fadlallah, 1983
Flabellum thouarsii (deep water)	Gonochoric				Waller, 2005
Fungia actiniformis	See *Heliofungia actiniformis*				
Fungia concinna	Gonochoric	Broadcast	X		Oliver, 1985
Fungia fungites	Gonochoric	Broadcast			Penland et al., 2004; Babcock et al., 1986
Fungia granulosa	Gonochoric	Broadcast			Kramarsky-Winter & Loya, 1998
Fungia horrida		Broadcast			Babcock et al., 2003
Fungia paumotensis	Gonochoric	Broadcast			Willis et al., 1985
Fungia repanda	Gonochoric	Broadcast			Hayashibara et al.,1993
Fungia scutaria	Gonochoric	Broadcast			Kolinski & Cox, 2003
Fungia scutaria	Parthenogenic?				Krupp, 1983
Fungia sp. (Okinawa)	Gonochoric	Broadcast			Heyward et al., 1987
Fungicyathus crispa	Gonochoric				Waller, 2005
Fungicyathus fragilis	Gonochoric				Waller, 2005
Fungiacyathus marenzelleri	Gonochoric				Waller, 2005
Galaxea aspera	?	Brooder			Fadlallah, 1983
Galaxea astreata	Hermaphroditic	Broadcast			Dai et al., 1992; Babcock et al., 1986
Galaxea fascicularis	Hermaphroditic, female sterile	Broadcast			Shlesinger et al., 1998; Hayakawa et al., 2005
Galaxea fascicularis	Gonochoric	Broadcast			Harrison & Wallace, 1990; Hayakawa et al., 2005
Galaxea horrescens		Brooder			ASIRA Data base
Gardineroseris planulata	Hermaphroditic				Glynn et al., 1996
Goniastrea aspera	Hermaphroditic	Broadcast			Penland et al., 2004
Goniastrea aspera	Hermaphroditic	Brooder			Nishikawa & Sakai, 2003
Goniastrea australensis	Hermaphroditic	Broadcast			Penland et al., 2004; Wilson & Harrison, 2005
Goniastrea edwardsi	Hermaphroditic	Broadcast			Penland et al., 2004
Goniastrea favulus	Hermaphroditic	Broadcast	X		Alvarado et al., 2003
Goniastrea favulus	Protandrous Hermaphrodite				Kojis & Quinn, 1981
Goniastrea palauensis	Hermaphroditic	Broadcast			Penland et al., 2004
Goniastrea pectinata	Hermaphroditic	Broadcast			Penland et al., 2004
Goniastrea retiformis	Hermaphroditic	Broadcast			Shlesinger et al., 1998
Goniocorella dumosa (deep water)	Gonochoric				Waller, 2005
Goniopora columna	Gonochoric	Broadcast			Willis et al., 1985
Goniopora dijboutiensis	Gonochoric	Broadcast			Willis et al., 1985
Goniopora fruticosa	Possibly sterile				Richmond & Hunter, 1990
Goniopora gigas	?	Broadcast			Petersen et al., 2007
Goniopora lobata	Gonochoric	Broadcast			Babcock & Heyward, 1986; Babcock et al., 1986
Goniopora minor	Gonochoric	Broadcast			Babcock et al., 1986
Goniopora norfolkensis	Gonochoric	Broadcast			Babcock et al., 1986
Goniopora palauensis		Broadcast			Babcock et al., 1986
Goniopora queenslandiae	Gonochoric	Brooder			Yamazato et al., 1975, in Fadlallah, 1983
Goniopora savignyi	Gonochoric	Broadcast			Shlesinger et al., 1998
Goniopora sp.	Gonochoric	Broadcast			Babcock et al., 1986
Goniopora sp. 1	Gonochoric	Broadcast			Babcock et al., 1986
Goniopora tenuidens	Gonochoric	Broadcast			Willis et al., 1985
Heliofungia actiniformis	Hermaphroditic (?)	Brooder			Abe, 1937 in Krupp, 1983; Fadlallah, 1983

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Heliofungia actiniformis	Gonochoric	Broadcast			Willis et al., 1985; Babcock et al., 1986
Helioseris cucullata		Brooder			NOAA Data base
Herpetoglossa simplex	Gonochoric	Broadcast			Babcock et al., 1986
Herpolitha limax	Gonochoric	Broadcast			Babcock et al., 1986
Heteropsammia aequicostatus	Gonochoric	Broadcast			Fisk, 1981
Heteropsammia cochlea	Gonochoric	Broadcast			Fisk, 1981
Hydnophora exesa	Hermaphroditic	Broadcast			Babcock et al., 1986
Hydnophora rigida	Hermaphroditic	Broadcast			Babcock et al., 1986
Isophyllastrea rigida	?	Brooder			Coral Reef Task Force data
Isophyllia dipsacea	Gonochoric	Brooder (external)			Fadlallah, 1985
Isophyllia sinuosa	Gonochoric	Brooder			Fadlallah, 1983
Isophyllia sp.	Gonochoric (?)	Broadcast			Babcock et al., 1986
Isopora brueggemanni	Hermaphroditic	Brooder			Okubo et al., 2007
Isopora togianensis	Hermaphroditic	Brooder			Wallace et al., 2007
Leptastrea bottae	Gonochoric	Broadcast			Kolinski & Cox, 2003
Leptastrea purpurea	Gonochoric	Broadcast			Kolinski & Cox, 2003
Leptopsammia pruvoti	Gonochoric	Brooder	X		Kružić et al., 2008
Leptoria phryia	Hermaphroditic	Broadcast			Dai et al., 1992; Babcock et al., 1986
Lobophyllia corymbosa	Hermaphroditic	Broadcast			Harriot, 1983
Lobophyllia hemprichii	Hermaphroditic	Broadcast			Willis et al., 1985
Lobophyllia pachysepta	Hermaphroditic	Broadcast			Marquis et al., 2005; Babcock et al., 1986
Lobophyllia sp.	Hermaphroditic				Marshall & Stephenson, 1933; in Fadlallah, 1983
Lophelia pertusa (deep water)	Gonochoric	?			Waller, 2005; Waller & Tyler, 2005
Madracis carmabi	Hermaphroditc	Brooder			Vermeij et al., 2004
Madracis decactis	Hermaphroditc	Brooder			Vermeij et al., 2004
Madracis formosa	Hermaphroditc	Brooder			Vermeij et al., 2004
Madracis mirabilis	Hermaphroditc	Brooder			Vermeij et al., 2004
Madracis pharensis	Hermaphroditc	Brooder		X	Vermeij et al., 2004
Madracis senaria	Hermaphroditc	Brooder		X	Vermeij et al., 2004
Madrepora oculata (deep water)	Gonochoric	?			Waller & Tyler, 2005
Manicina areolata	Hermaphroditic	Brooder			Fadlallah, 1983
Meandrina areolata	?	Brooder			Yonge, 1935, in Fadlallah, 1983
Meandrina meandrites		Brooder			NOAA Data base
Merulina ampliata	Hermaphroditic	Broadcast			Penland et al., 2004; Babcock et al., 1986
Merulina scabricula	Hermaphroditic	Broadcast			Hayashibara et al.,1993
Micromussa amakuensis		Broadcast			Mezaki et al., 2007
Montastrea magnistellata	Hermaphroditic	Broadcast			Babcock et al., 1986
Montastrea annularis	Hermaphroditic	Broadcast			Alvarado et al., 2003
Montastrea annuligera	Hermaphroditic	Broadcast			Babcock et al., 1986
Montastrea cavernosa	Gonochoric	Broadcast			Alvarado et al., 2003
Montastrea curta	Hermaphroditic	Broadcast			Wilson, 1997; Babcock et al., 1986
Montastrea faveolata	Hermaphroditic	Broadcast		X	Levitan et al., 2004; Steiner, 1995
Montastrea franksi	Hermaphroditic	Broadcast			Levitan et al., 2004; Szmant et al., 1997
Montastrea valenciennesi	Hermaphroditic	Broadcast			Dai et al., 1992; Babcock et al., 1986
Montipora aequituberculata	Hermaphroditic	Broadcast			Dai et al., 1992
Montipora altasepta	Hermaphroditic	Broadcast		X	Penland et al., 2004
Montipora cactus	Hermaproditic	Broadcast			Penland et al., 2004; Wallace et al., 2007
Montipora capitata	Hermaproditic	Broadcast			Heyward, 1986
Montipora crassituberculata	Hermaproditic				Penland et al., 2004
Montipora digitata	Hermaproditic	Broadcast			Penland et al., 2004; Morita et al., 2006
Montipora dilatata	Hermaproditic	Broadcast			Heyward, 1986
Montipora efflorescens	Hermaphroditic	Broadcast			Wallace et al., 2007
Montipora effusa		Broadcast			Yeemin, 1988
Montipora erythraea	Hermaproditic	Broadcast			Shlesinger et al., 1998
Montipora eydouxi	Hermaphroditic	Broadcast			Hirose et al., 2000
Montipora faveolata	Hermaphroditic	Broadcast			Richmond & Hunter, 1990
Montipora flabellata	Hermaphroditic	Broadcast			Heyward, 1986
Montipora floweri	Hermaphroditic	Broadcast			Hayashibara et al.,1993

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Montipora foliosa	Hermaphroditic	Broadcast	n/a	n/a	Dai et al., 1992
Montipora hispida	Hermaproditic	Broadcast			Penland et al., 2004; Babcock et al., 1986
Montipora informis	Hermaphroditic	Broadcast			Dai et al., 1992
Montipora monasteriata	Hermaphroditic	Broadcast			Babcock et al., 1986
Montipora patula	Hermaphroditic	Broadcast			Heyward, 1986
Montipora peltiformis		Broadcast			Mundy & Babcock, 1998
Montipora ramosa		Broadcast			Harrison et al., 1984
Montipora samarensis	Hermaphroditic				Penland et al., 2004
Montipora spumosa	Hermaphroditic	Broadcast			Babcock et al., 1986
Montipora studeri	Hermaphroditic	Broadcast			Heyward, 1986
Montipora tuberculosa		Broadcast			Babcock & Heyward, 1986
Montipora turgescens	Hermaphroditic	Broadcast			Babcock et al., 1986
Montipora turtlenesis	Hermaphroditic	Broadcast			Babcock et al., 1987
Montipora venosa	Hermaphroditic	Broadcast			Dai et al., 1992; Hayashibara et al.,1993
Montipora verrilli	Hermaphroditic	Broadcast			Heyward, 1986
Montipora verrucosa	Hermaphroditic	Broadcast			Maté et al., 1998
Moseleya latistellata	Hermaphroditic	Brooder			Wallace et al., 2007
Mussa sp.	Hermaphroditic				Steiner, 1993
Mussa angulosa		Brooder			Coral Reef Task Force data
Mussismilia braziliensis	Hermaphroditic	Broadcast			Pires et al., 1999
Mussismilia hartii	Hermaphroditic	Broadcast			Pires et al., 2002
Mussismilia hispida	Hermaphroditic	Broadcast			Pires et al., 2002
Mussismilia sp.	Hermaphroditic				Pires et al., 1999
Mycedium elephantotus	Hermaphroditic	Broadcast			Babcock & Heyward, 1986
Mycetophyllia ailiciae	Hermaphroditic	Brooder			Szmant, 1986
Mycetophyllia danaana		Brooder			Coral Reef Task Force data
Mycetophyllia ferox	Hermaphroditic	Brooder			Szmant, 1986
Mycetophyllia lamarckiana		Brooder			Coral Reef Task Force data
Mycetophyllia reesi		Brooder		X	Coral Reef Task Force data
Oulastrea crispa	Hermaphroditic	Broadcast			Lam, 2000
Oulastrea crispa	Hermaphroditic	Brooder			Lam, 2000
Neohelia porcellana	Gonochoric (?)				Pratt, 1900, in Fadlallah, 1983
Oculina sp.		Broadcast			Brooke & Young, 2003
Oculina varicosa	Gonochoric	Broadcast			Brooke & Young, 2003
Oculina patagonica	Gonochoric	Broadcast			Fine et al., 2001
Oulophyllia bennettae	Hermaphroditic	Broadcast			Bermas et al., 1992
Oulophyllia crispa	Hermaphroditic	Broadcast			Babcock et al., 1986
Oxypora glabra	Hermaphroditic	Broadcast			Babcock et al., 1986
Oxypora lacera	Hermaphroditic	Broadcast			Mundy & Babcock, 1998; Babcock et al., 1986
Pachyseris rugosa	Gonochoric	Broadcast			Dai et al., 1992; Babcock et al., 1986
Pachyseris speciosa	Gonochoric	Broadcast			Penland et al., 2004; Baird et al., 2001
Pavona cactus	Gonochoric	?			Marshall & Stephenson, 1933; in Fadlallah, 1983
Pavona duerdeni	Gonochoric	Broadcast			Kolinski & Cox, 2003
Pavona explanata	Gonochoric (?)				Stimson, 1978
Pavona gigantea	Gonochoric	Broadcast			Glynn et al., 1996
Pavona varians	Gonochoric	Broadcast			Maté, 1998; Shlesinger et al., 1998
Pectinia alcicornis	Hermaphroditic	Broadcast			Penland et al., 2004; Babcock & Hey ward,1986
Pectinia lactuca	Hermaphroditic	Broadcast			Bermas et al., 1992
Pectinia paeonia	Hermaphroditic	Broadcast			Babcock & Heyward, 1986
Physogyra lichtensteini	Gonochoric	Broadcast			Babcock et al., 1986 & 2003
Platygyra contorta	Hermaphroditic	Broadcast			Hayashibara et al.,1993
Platygyra daedalea	Hermaphroditic	Broadcast			Mangubhai & Harrison, 2008
Platygyra lamellina	Hermaphroditic	Broadcast			Shlesinger et al., 1998; Dai et al., 1992
Platygyra pini	Hermaphroditic	Broadcast			Mangubhai & Harrison, 2008
Platygyra ryukuensis	Hermaphroditic	Broadcast			Heyward, 1988
Platygyra sinensis	Hermaphroditic	Broadcast			Wallace et al., 2007; Oliver and Babcock, 1992
Platygyra verweyi	Hermaphroditic	Broadcast			Mangubhai & Harrison, 2008
Plerogyra sinuosa		Broadcast			ASIRA Data base
Plesiastrea verispora		Broadcast			Dai et al., 1992
Pocillopora bulbosa	See *P. damicornis*	Brooder			Goffredo et al., 2006

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Pocillpora brevicornis	See *P. damicornis*				
Pocillopora caespitosa	See *P. damicornis*	Brooder	X		Benayahu et al., 1992
Pocillopora damicornis	Hermaphroditic	Brooder			Ward, 1992
Pocillopora damicornis	Parthenogenic?				Permata et al., 2000
Pocillopora damicornis		Broadcast			Ward, 1992
Pocillopora damicornis Type Y		Brooder			Stimson, 1987
Pocillopora damicornis Type B		Brooder			Stimson, 1987
Pocillopora elegans	?	Brooder			Stimson, 1978
Pocillopora eydouxi	Hermaphroditic	Broadcast			Hirose et al., 2000
Pocillopora meandrina	Hermaphroditic	Broadcast			Stimson, 1978
Pocillopora verrucosa	Hermaphroditic	Broadcast			Shlesinger et al., 1998
Pocillopora verrucosa	?	Broadcast			Stimson, 1978
Podabacia crustacea	Gonochoric	Broadcast			Babcock et al., 1986
Polyphyllia talpina	Gonochoric	Broadcast			Willis et al., 1985
Porites andrewsi	Gonochoric	Broadcast			Kojis & Quinn, 1981
Porites annae		Broadcast			Dai et al., 1992
Porites astreoides	Hermaphroditic	Brooder			Brazeau et al., 1998
Porites astreoides	Hermaphroditic & Female	Brooder			Chornesky & Peters, 1987
Porites astreoides	Hermaphrodite & Female/ Male	Brooder			Soong, 1991
Porites attenuata		Brooder			ASIRA Data base
Porites australensis	Gonochoric	Broadcast			Neves, 1998
Porites branneri		Brooder	X		Coral Reef Task Force data
Porites brighami	Gonochoric or Hermaphroditic	Brooder		X	Hunter & Hodgson in Richmond & Hunter, 1990
Porites clavaria	Gonochoric	Brooder			Duerden, 1902, in Fadlallah, 1983
Porites colonensis		Brooder			Coral Reef Task Force data
Porites compressa	Gonochoric	Broadcast			Kolinski & Cox, 2003
Porites cylindrica	Gonochoric	Broadcast			Babcock et al., 1986
Porites divaricata		Brooder			Coral Reef Task Force Data
Porites evermanni	Gonochoric	Broadcast			Neves, 1998
Porites furcata	Gonochoric	Brooder			Soong, 1991
Porites haddoni	see *Porites stephensoni*	Brooder			Soong, 1991
Porites heronensis		Brooder (?)			Harriot & Banks, 1995
Porites lichen	Hermaphroditic	Brooder			Kolinski & Cox, 2003
Porites lobata	Gonochoric	Broadcast			Penland et al., 2004
Porites lobata	Parthenogenic?				Fadlallah, 1983
Porites lutea	Gonochoric	Broadcast			Richmond & Hunter, 1990
Porites lutea	Parthenogenic?				Fadlallah, 1983
Porites murrayensis	Gonochoric	Brooder			Neves, 1998
Porites panamensis	Gonochoric	Brooder			Glynn et al., 2008
Porites porites	Gonochoric	Brooder			Tomascik & Sander, 1987
Porites porites	Hermaphroditic				Tomascik & Sander, 1987
Porites rus	Gonochoric	?			Richmond & Hunter, 1990
Porites solida	Gonochoric	Broadcast			Babcock et al., 1986
Porites stephensoni	?	Brooder			Soong, 1993
Psammocora contigua	Gonochoric	Broadcast			Babcock et al., 1986
Psammocora digitata	Gonochoric	Broadcast			Babcock et al., 1986
Psammocora stellata	?	Brooder			Kolinski & Cox, 2003
Rhizopsammia minuta		Brooder			Abe, 1939, in Fadlallah, 1983
Sandalolitha robusta	Gonochoric	Broadcast			Babcock et al., 1986
Scapophyllia cylindrica	Hemaphroditic	Broadcast		X	Willis et al., 1985
Scolymia sp. (Atlantic)	?	Brooder			Coral Reef Task Force Data base
Scolymia cubensis	See *Scolymia wellsi*				
Scolymia vitiensis	Hemaphroditic	Broadcast			Willis et al., 1985
Scolymia wellsi	Hemaphroditic	Brooder		X	Pires et al., 2000
Scolymia wellsi	Gonochoric (?)	Brooder			Pitombo, 1992
Seriatopora caliendrum	Hermpahroditic	Brooder			Shlesinger et al., 1998
Seriatopora hystrix	Hermpahroditic	Brooder			Fadlallah, 1983
Siderastrea radians	Gonochoric	Brooder			Soong, 1991
Siderastrea radians	Hermaphroditic	Brooder		X	Duerden, 1902, in Coral Reef Task Force Data base
Siderastrea radians	Protandrous Hermaphrodite				Duerden, 1902, in Fadlallah, 1983

Taxon	Sexuality	Reproduction	Vertical (egg)	Horizontal water 85%	Reference
Siderastrea siderea		Brooder			Neves et al., 2008
Siderastrea siderea	Gonochoric	Broadcast			Szmant, 1986
Siderastrea stellata		Brooder			Neves et al., 2008
Solenastrea boumoni		Broadcast			Coral Reef Task Force Data base
Solenastrea hyades		Broadcast			Coral Reef Task Force Data base
Solensomilia variabilis	Gonochoric	Broadcast (?)			NOAA Technical Memo NMFS-OPR-28
Stephanocoenia intercepta	Gonochoric	Broadcast			Coral Reef Task Force data
Stephanocoenia michelini	Gonochoric	Broadcast			Smith, 1997
Stephanophyllia formosissima		Brooder			Moseley, 1881, in Fadlallah, 1983
Stylocoeniella sp.	Gonochoric				Harrison, 1985
Stylophora mordax		Brooder			Brown et al., 1998
Stylophora pistillata	Hermaphroditic	Brooder			Shlesinger & Loya, 1985
Stylophora pistillata	Protandrous Hermaphrodite				Loya, 1976
Symphyllia radians	Hermaphroditic	Broadcast			Babcock et al., 1986
Symphyllia recta	Hermaphroditic	Broadcast			Babcock et al., 1986
Symphyllia sp.	Hermaphroditic				Willis et al., 1985
Tubastraea aurea	See *Tubastraea coccinea*				
Tubastraea coccinea	Hermaphroditic	Brooder			Paz-Garcia et al., 2007
Tubastraea faulkneri	Gonochoric	Brooder			Babcock et al., 1986
Turbinaria frondens	Gonochoric				Willis et al., 1985
Turbinaria mesenterina		Broadcast			Willis, 1987
Turbinaria reniformis	Gonochoric	Broadcast	X		Willis et al., 1985
Turbinaria sp.	Gonochoric	Broadcast			Harrison et al., 1984

FEATURE ARTICLE

TOTAL ORGANIC CARBON (TOC) AND THE REEF AQUARIUM: AN INITIAL SURVEY, PART II

By Ken S. Feldman, Kelly M. Maers

Department of Chemistry, The Pennsylvania State University, University Park, PA 16802. Ken and Kelly continue to report on their work on Total Organic Carbon and how it relates to the reef aquarium.

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Editor's Note: This article continues from last month's Advanced Aquarist.

A SURVEY OF TOC LEVELS IN MARINE AQUARIA RUN UNDER DIFFERENT HUSBANDRY CONDITIONS

Water samples from 6 different marine aquaria spanning a range of husbandry conditions were examined for TOC levels. For standardization of the experimental protocol, samples were taken at approximately (a) 0.5 - 2 hours after feeding, (b) 10-12 hours after feeding, and (c) 20-24 hours after feeding. Key tank parameters, aquarium characteristics and husbandry techniques are detailed along with the measured TOC values. All tanks appeared in general to be healthy with thriving livestock and stable conditions.

1. 500 GALLON REEF TANK

- System volume: 550 gallons
- Salt mix: Instant Ocean
- Refugium: No
- Routine additives: none
- Sand bed: 0.5 - 2 inches
- Skimmer: DIY downdraft
- GAC: 2 cups
- Water change: 10% biweekly
- Ca reactor: DIY
- Livestock: fish (> 30) , hard corals, soft corals, snails, starfish, cucumbers, shrimp, live rock
- Feeding Schedule: 2 tsp frozen meaty food, 2/day

2. 55-GALLON REEF TANK

- System volume: 55 gallons
- Salt mix: Instant Ocean
- Refugium: No
- Routine additives: none
- Sand bed: no
- Skimmer: no
- GAC: 1 cup
- Water change: rarely
- Ca reactor: no
- Livestock: fish (7, ~ 16 inches in total), soft corals, starfish, live rock
- Feeding Schedule: 0.75 tsp frozen meaty food, 1/day

3. 29-GALLON REEF TANK

- System volume: 29 gallons
- Salt mix: Instant Ocean
- Refugium: No
- Routine additives: none
- Sand bed: no
- Skimmer: no
- GAC: no
- Water change: rarely
- Ca reactor: no
- Livestock: fish (4, ~ 9 inches in total), soft corals, starfish, shrimp, live rock
- Feeding Schedule: 0.5 tsp frozen meaty food, 1/day

- Inorganic nutrient levels: [NH_4] < 0.25 ppm (test limit), [NO_3] 50 ppm, [NO_2] = 2 ppm, [Ca] = 405 ppm, [Mg] = 1365 ppm, [alk] = 2.40 meq/L (Salifert); [PO_4] > 0.43 ppm (Merck test limit)

4. 30-GALLON CORAL FRAG PROPAGATION SYSTEM

- System volume: 30 gallons
- Salt mix: Instant Ocean
- Refugium: No
- Routine additives: none
- Sand bed: no
- Skimmer: Aqua C Remora
- GAC: yes
- Water change: 17%/week
- Ca reactor: no
- Livestock: hard corals, shrimp, snails
- Feeding Schedule: 0.5 tsp Phytofeast, 0.5 tsp Rotifeast, 1/day

5. 250-GALLON REEF TANK

- System volume: 370 gallons

Figure 8. Invertebrate population in the author's tank during the "week in the life" study.

- Salt mix: Instant Ocean
- Refugium: Yes
- Routine additives: none
- Sand bed: 2 inches
- Skimmer: Aquamedic
- GAC: yes
- Water change: 10%/2 weeks
- Ca reactor: Yes
- Livestock: fish (22, ~ 75"), hard corals, soft corals, live rock, crabs, snails, cukes, starfish
- Feeding Schedule: 1 tsp meaty food, 1 tsp flakes, 1/16 tsp pellets, 4 sq inches nori @ 2 or 3 times/day

6. 500-GALLON REEF TANK

- System volume: 600 gallons
- Salt mix: Instant Ocean
- Refugium: Yes
- Routine additives: Ca, Mg
- Sand bed: 2 inches
- Skimmer: ETSS 1200
- GAC: yes
- Water change: 7%/week
- Ca reactor: Yes

Figure 9. Full tank photograph of the 500-gallon reef aquarium.

Figure 10. Full tank photograph of the 55-gallon reef aquarium.

Figure 11. Full tank photograph of the 29-gallon reef aquarium.

Figure 12. Full tank photograph of the 30-gallon coral propagation system.

Figure 13. Full tank photograph of the 250-gallon reef tank

Figure 14. Full tank photograph of the 500-gallon reef tank

- Livestock: fish (~ 60, ~ 140 inches), hard corals, soft corals, live rock, crabs, snails, cukes, starfish
- Feeding Schedule: 3 tsp meaty food, 2 tsp flakes, 1 tsp pellets, 4 sq inches nori @ 1 time/day

Four of the seven aquaria examined in this study (the author's tank and tanks # 1, 5, and 6) are reef tanks that fit the standard Berlin model: sand, rocks, a protein skimmer, and GAC (Granular Activated Carbon). All of these tanks have diverse livestock including fish, corals, snails, and assorted other invertebrates. Interestingly, all of the "standard model" tanks exhibited TOC values that mapped closely onto the range observed for healthy, thriving natural reefs; 0.7 - 1.4 ppm. The three remaining successful aquaria do not contain one or more of the "standard model" components, and the TOC values of these atypical tanks are on the outside edges, or deviate entirely, from natural reef values. For example, tank #4 lacks sand and rock, but does have a skimmer and uses GAC. No fish are in residence, as the livestock consists of only hard coral frags and a few snails and shrimp. Thus, the presumed major repositories of bacteria (sand and rocks) are missing, and there is only minimal coral volume to house bacteria. For this tank, the TOC values (~ 1.2 - 1.6 ppm) are at the upper edge or exceed those found on natural reefs. Nevertheless, the coral frags apparently have adapted and are thriving. Tank #2 lacks sand and a skimmer, but it does contain generous amounts of live rock, a few fish, and several large, mature colonies of soft corals; significantly, GAC is used continuously. The TOC values found in this tank (~ 0.7 ppm) are at the lower edge of the range found on natural reefs. Finally, tank 3 is the most primitive of all; no water purification equipment (skimmer or GAC) is employed, some live rock is incorporated, and no sandbed is present. Nevertheless, the fish and soft corals are thriving. The TOC levels in this aquarium are exceptionally high (> 5 ppm), as are the nitrate and phosphate concentrations. Presumably, the absence of purification equipment is reflected in the high TOC and nitrate/phosphate levels; all the same, the livestock seems to have adapted. The somewhat subversive thesis that perhaps skimmers do not contribute much to TOC removal/water purification was raised in the discussion of Figs. 5 and 6; the exceedingly low TOC values in the skimmerless tank #2 provide further support for this notion. What then, distinguishes this tank from the other skimmerless tank, #3, which has exceedingly high TOC levels? Both tanks lack sandbeds and have similar fish loads and soft coral/ invertebrate populations. The one identifiable difference in husbandry between them involves GAC; the low TOC tank (#2) uses GAC-based water filtration, whereas the high-TOC tank (#3) does not. Does GAC really make such a spectacular difference in TOC loads while at the same time protein skimmers scarcely have any effect at all? This question and related topics are currently under study, and results will be reported in the near future.

1. TOC Concentrations: 500 Gallon Reef Tank

entry	time since last feeding, hours	measured TOC, ppm
1	0.5	0.94 ± 0.07
2	1	1.31 ± 0.09
3	1.5	1.24 ± 0.05
4	10	1.41 ± 0.10
5	14.25	1.13 ± 0.02
6	20	1.46 ± 0.09
7	24	1.10 ± 0.20

2. TOC Concentration: 55 Gallon Reef Tank

entry	time since last feeding, hours	measured TOC, ppm
1	1	0.71 ± 0.04
2	10	0.69 ± 0.05
3	20	0.59 ± 0.05

3. TOC Concentration: 29 Gallon Reef Tank

entry	time since last feeding, hours	measured TOC, ppm
1	1.5	5.5 ± 0.2
2	10	5.4 ± 0.5
3	20	5.9 ± 0.3

4. TOC Concentration: 30 Gallon Coral Propagation System

entry	time since last feeding, hours	measured TOC, ppm
1	1	1.63 ± 0.03
2	9	1.44 ± 0.06
3	24	1.20 ± 0.03

5. TOC Concentration: 250 Gallon Reef Tank

entry	time since last feeding, hours	measured TOC, ppm
1	1	0.65 ± 0.01
2	11	0.62 ± 0.3
3	24	0.63 ± 0.02

6. TOC Concentration: 500 Gallon Reef Aquarium

entry	time since last feeding, hours	measured TOC, ppm
1	1	1.10 ± 0.01
2	11	1.01 ± 0.02
3	24	0.97 ± 0.01

Conclusions

Coral reefs have been characterized as oases of biological productivity in a marine desert (Capone, 1992). The surrounding oligotrophic (= nutrient depleted) waters provide little sustenance to the reef biota. As a consequence, complex nutrient recycling webs have evolved on reefs to retain and reutilize essential elements like nitrogen and carbon. The carbon cycle on reefs is multifaceted and is beginning to be unraveled. Reliable measurements of dissolved organic carbon (DOC) levels are critical for this goal, and the introduction of the Shimadzu TOC Analyzer represents an unequivocal leap forward in research capability. On thriving reefs, most carbon input originates with atmospheric CO_2, which is "fixed" via photosynthesis first into carbohydrates, and then into a multitude of other organic molecules. Much of this carbon, which is generated by the zooxanthellae in corals, is reemitted as coral mucus. This coral contribution significantly enriches the pool of DOC. This DOC is prime food for a large variety of reef microbiota, including bacteria, both in the water column and in the corals themselves, and microplankton, etc. Finally, these microflora and microfauna serve as food for a variety of filter feeders, including, again, the corals. Thus, the interdependency of reef organisms, both large and small, is revealed as the carbon-based nutrients are recycled. The surrounding oligotrophic ocean serves as a buffer which can absorb excess nutrients that might otherwise prove harmful to reef inhabitants and modulate the levels of dissolved species by import and export, depending

on relative (reef vs. open ocean) concentrations. Our captive reefs fall far short of this nutrient commerce model; we have, of course, no open ocean buffer to dilute away waste and so we rely on water changes to perform this vital function, and it remains unclear whether our aquaria contain all of the components, in appropriate proportions, of authentic reefs necessary to promote efficient nutrient recycling. Nevertheless, what we do seems to work, at least most of the time. But, what happens when things go wrong? Circumstantial evidence from Rohwer's studies implicates DOC imbalances in coral mortality, with runaway bacterial growth as a likely mediating culprit. Can these observations inform aquarists, and is there a response that might ameliorate the problem? Certainly the first step is to establish a baseline of TOC (DOC) levels in healthy reef aquaria under different husbandry protocols. In this article, data has been presented that accomplishes this goal, and further, validates these TOC numbers by comparison to TOC/DOC levels on healthy reefs around the world. In addition, the surprisingly minimal impact of protein skimming on TOC levels was revealed. On this point, it is apparent that if TOC levels can be monitored to assay the effects of one skimmer (the H&S A200 in this case), then they can be monitored to measure the impact of different types of skimmers operating on an experimental tank. In addition, these types of experiments also can be used to probe more directly and quantitatively the TOC removal capabilities of Granular Activated Carbon (GAC) that was

hinted at in the tank #2 vs. tank #3 comparison. These types of experiments might allow, for the first time, a quantitative evaluation of skimmer and, independently, GAC performance which is divorced from the hype and misinformation that seems to surround these areas of marine aquarium maintenance/equipment. These experiments are ongoing and results will be reported in due course.

Finally, the goal of identifying approaches to halt incidents of coral mortality in reef tanks may benefit from data collection from "sick" tanks rather than the healthy aquaria examined in this study. If tanks undergoing coral crashes have an unusually high (or low) amount of TOC in the water but otherwise have acceptable water parameters, then a new and otherwise unappreciated villain will be in hand. Under these circumstances, what can the aquarist do? One experiment described by Ferrier-Pagès on *Galaxea* provides food for thought. Specimens of this coral were treated with the combined antibiotics penicillin, streptomycin, and amphotericin; subsequent bacterial uptake of DOC, which Rohwer identified as a mechanism for coral mortality when occurring in excess, ceased.

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FEATURE ARTICLE

MICRO-ECOSYSTEMS

By Jay Hemdal

When experimenting with these small scale closed systems, it is vitally important to be backed up by your already solidly operating typical marine aquariums, so that you are better prepared to ultimately succeed with these experimental closed mini eco-systems.

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Imagine a device that has a water pump that sends water to the top of a tower and then releases it. As the water spills down due to force of gravity, the water spins a generator that in turn produces electrical energy to drive the pump, which sends more water to the top of the tower - and so on forever. As a youngster, I imagined such a perpetual motion device might work until my father (an electrical engineer) explained to me that friction, increasing entropy and the realities of conservation of energy would all combine to make such a device unworkable (on Earth at least).

Over the years, a similar idea has cropped up in aquarium keeping. Imagine being able to hold a sealed ecosystem in your hand, or have a totally closed micro-aquarium sitting on a shelf. The autotrophic algae and plants it contains would serve as food for the heterotrophic animals with the waste products from the animals serving as nutrients for the autotrophs. So, the animals in such a system would utilize the oxygen given off by photosynthetic organisms and they would in turn make use of the carbon dioxide and waste products given off by the animals to fuel their own growth. The only external energy input to such a system would be light. People have long sought to develop biological systems that would run forever like a perpetual motion device. The same sort of restrictions on perpetual motion devices will however, causes these closed ecosystems to wind down and eventually fail. Still, some aquarists are drawn to the idea of closed ecosystems, and by following some basic ideas, intriguing systems can be established and studied.

Commercially available hermetically sealed micro-ecosystem.

These ecosystems can either be "closed" or "open" in respect to energy. A completely closed system that does not have any energy input (even from light) is theoretically possible using chemotrophic bacteria. These systems would have little interest to aquarium hobbyists because they would need to be kept in the dark and the only organisms in them would be microscopic bacteria. Open systems (in respect to energy) allow for more interesting animals and plants to be maintained.

In attempting to define these ecosystems, it is helpful to consider the following variations on the theme. These four basic systems differ in the degree to which they are closed to the outside environment.

1. **Hermetically sealed micro-ecosystems**: These systems are totally sealed in respect to any physical input from the environment around them. The primary energy input is the light that reaches the plants inside. Whatever air, water, nutrients and animals that are present when the ecosystem was sealed are all that are available to maintain the ecosystem.

2. **Closed systems**: These ecosystems are closed to the environment around them with the exception that they allow for the passive exchange of atmospheric gasses. Again, the primary energy input is light to drive the process of photosynthesis. Most hermetically sealed ecosystems do not incorporate a sufficient amount of air in the system. By allowing exchanges of gases, these systems avoid that problem, but are still closed in respect to food energy, water changes and additions of plants or animals.

3. **Semi-closed systems**: As with the closed systems described above, some gas exchange is allowed. In addition, the next most easily degraded component of these ecosystems - water quality, is kept within appropriate parameters by performing partial water changes. These water changes replace inorganic nutrients that may have become chemically or biologically bonded and thus removed from the ecosystem. Still, there is no energy added to the system except for light and sufficient heat to maintain a level proper for the organisms being maintained.

4. **Open systems**: These systems rely on atmospheric gas and water exchanges as do semi-closed systems, but in addition, there are moderate inputs of supplemental food energy for the heterotrophic animals. This allows for a higher density of these organisms to be maintained - making a more aesthetically pleasing system. The only difference between open systems and a regular aquarium is that no active filtration is used, and the species present in the system are left unchanged, no new plants or animals are added.

A second energy pathway that needs to be considered in all four of these models is heat energy, or infrared radiation. Infrared radiation entering the system can have a profound affect on the plants and animals. Too low heat energy and some biological functions will shut down. Too much infrared radiation will cause the water temperature may rise to levels lethal to the plants and animals.

Anyone interested in experimenting with closed ecosystem aquariums, needs to have a reasonable expectations as to the results that will be obtained. Vertebrates, (fish in this case) are not well suited for living in micro-ecosystems; they should only be kept in properly maintained aquariums. This leaves invertebrates, algae and plants as suitable organisms for stocking the ecosystem. The hardier the species, the better, as these ecosystems sometimes experience wide fluctuations in their environmental conditions that may harm more delicate animals and plants. Micro-ecosystems also require a very low density of animals and plants. This helps keep the system more stable. Remember that most of the species suitable for these systems are not very large and are often not very colorful. If your desire is to have an ecosystem filled with all manner of organisms, your best bet would be to consider a regular aquarium. If on the other hand, the idea of a closed, or partially closed ecosystem intrigues you, consider setting up a small system as described below.

The first step to take should you decide to try to build an ecosystem is to determine if you want to create a freshwater or marine habitat. It is advisable for beginning aquarists to choose a freshwater ecosystem, as their marine counterparts are more complicated to operate and seem to be inherently less stable. After the basic water type has been selected, decide which of the four types of ecosystems you wish to establish. After that, read the following section that describes that system and then determine what type of vessel you plan to use. Use your imagination in selecting a container to hold your ecosystem - antique bottles and vases have been used, as have five-gallon water carboys. Depending on the type of system, the top can either be left off or sealed with some temporary material such as wax.

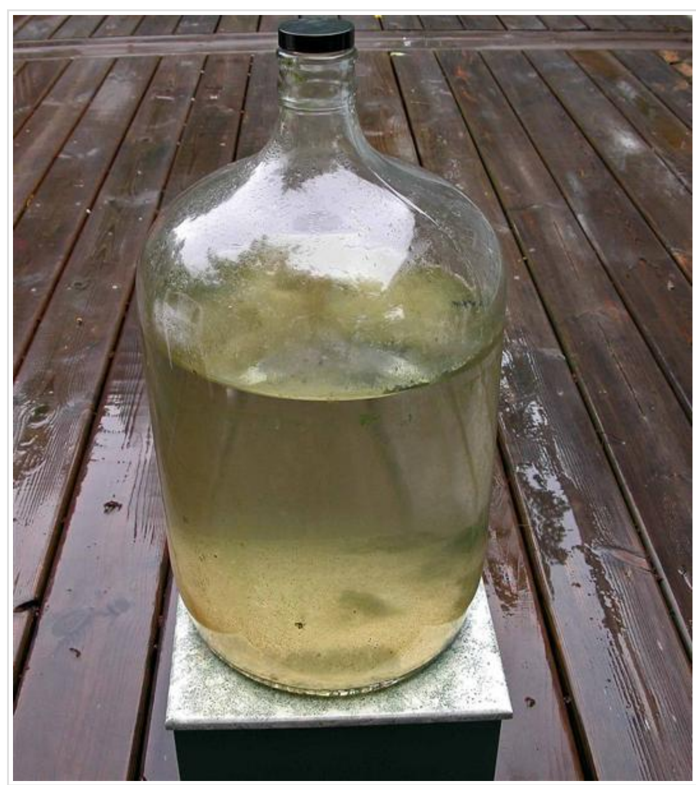
Once the basic format of the ecosystem has been determined, choose appropriate species to add to the system, and follow the instructions in each section in terms of the order in which to add the specimens, as well as the amount of them to add. Table 1 lists some species that have been used to populate ecosystem aquariums.

Hermetically sealed ecosystems

This type of mini-ecosystem is considered the epitome of the genre; a totally enclosed system that only uses light energy to maintain the life functions of the animals and plants that reside, all locked inside. As mentioned, a truly self-sustaining, stable sealed ecosystem is really a pipe dream, no more achievable than a perpetual motion device. However, for the short term (months to perhaps a few years) these sealed systems may maintain stability. While they are in their prime condition, they are truly remarkable to observe. These systems are less decorative than the other systems because the animal and plant life they contain must be very small in order to survive and reproduce in such a small volume of water. The majority of the systems seen are sold as complete units called Ecospheres by a company that developed a system that incorporates a tiny red shrimp (*Halocaridina rubra*) and some algae. These ready-made units are rather expensive, but very decorative.

It is difficult to duplicate this sort of sealed ecosystem in the home. However, those who wish to try should begin with using some sand or gravel substrate from an existing aquarium. This allows for a mature population of microscopic plants and animals to already be

A hermetically sealed Ecosphere that is still viable after almost five years.



Five gallon carboy after being sealed for ten years.

present in the system prior to its being sealed. Since you only have one chance (when you first set the system up), balancing the energy cycle shown in figure one is impossible to do accurately, so just make your best guess. The system will reach equilibrium on its own as time goes on. Remember that most of these sealed ecosystems suffer from too high of a stocking density, so start with just a few specimens. Never try to incorporate a fish into a sealed system, this is cruel and the fish will soon die. For freshwater systems, consider using a few pond snails and a sprig of Hornwort or Anacharis plants. Marine systems can use *Aiptasia* sea anemones, *Asterina* starfish and *Caulerpa* algae.

Once the system has been sealed, the only variables that can be controlled by the aquarist are light and temperature. It is best to just keep the temperature stable, and concentrate on varying the light intensity in order to try to balance the system. If the algae or plants in the system seem to be fading or dying back, increase the light intensity and duration. If the plant life threatens to overwhelm the system, reduce the light by some amount.

It seems that at least some of these sealed systems do better if held under 24-hour lighting. While the plants are actively photosynthesizing, they absorb carbon dioxide and release oxygen. This causes the pH of the water to rise. At night, reverse phase photosynthesis occurs, and carbon dioxide is given off by both the plants and the animals. This can cause the pH to drop - possibly to a level that would prove fatal to the animals. By lighting the system with a moderate amount of light at all times, this radical swing in pH can be avoided. Of course, there is a tendency for the plants to overgrow the system when held under constant light, but this problem can be partially solved by increasing the distance between the ecosystem and its light source. Figure one diagrams a hermetically sealed aquarium system.

In one experiment, a five-gallon carboy was left sealed for ten years. Initially it was stocked with seawater and tiny pieces of live rock from an established aquarium. For the first year or so, some activity was seen inside - with populations of invertebrates and algae growing and changing. After that point, the system seemed to shut down

Table 1. Potential hardy species for ecosystem aquariums

Common Name	Scientific name	Water type	Notes
Willow moss	*Fontinalis sp.*	Freshwater	Prefers cooler temperatures
Unequal arm starfish	*Asterina sp.*	Marine	May reproduce in captivity
Thallose algae	*Caulerpa sp.*	Marine	Very hardy, many species
Shrimp	*Mysis sp.*	Marine	Usually will not reproduce
Pond weed	*Anacharis / Elodea sp.*	Freshwater	Hardy - lower light need
Malaysian snail	*Melanoides sp.*	Freshwater	Hardy algae feeder
Hornwort	*Ceratophyllum sp.*	Freshwater	Very hardy - moderate light
Hermit crab	*Pagurus sp.*	Marine	Usually requires feeding
Glass anemone	*Aiptasia sp.*	Marine	May become a pest species
Chain algae	*Halimeda sp.*	Marine	Requires high calcium levels
Bubble algae	*Valonia sp.*	Marine	May become a pest
Bladderwort	*Ultricularia sp.*	Freshwater	Delicate

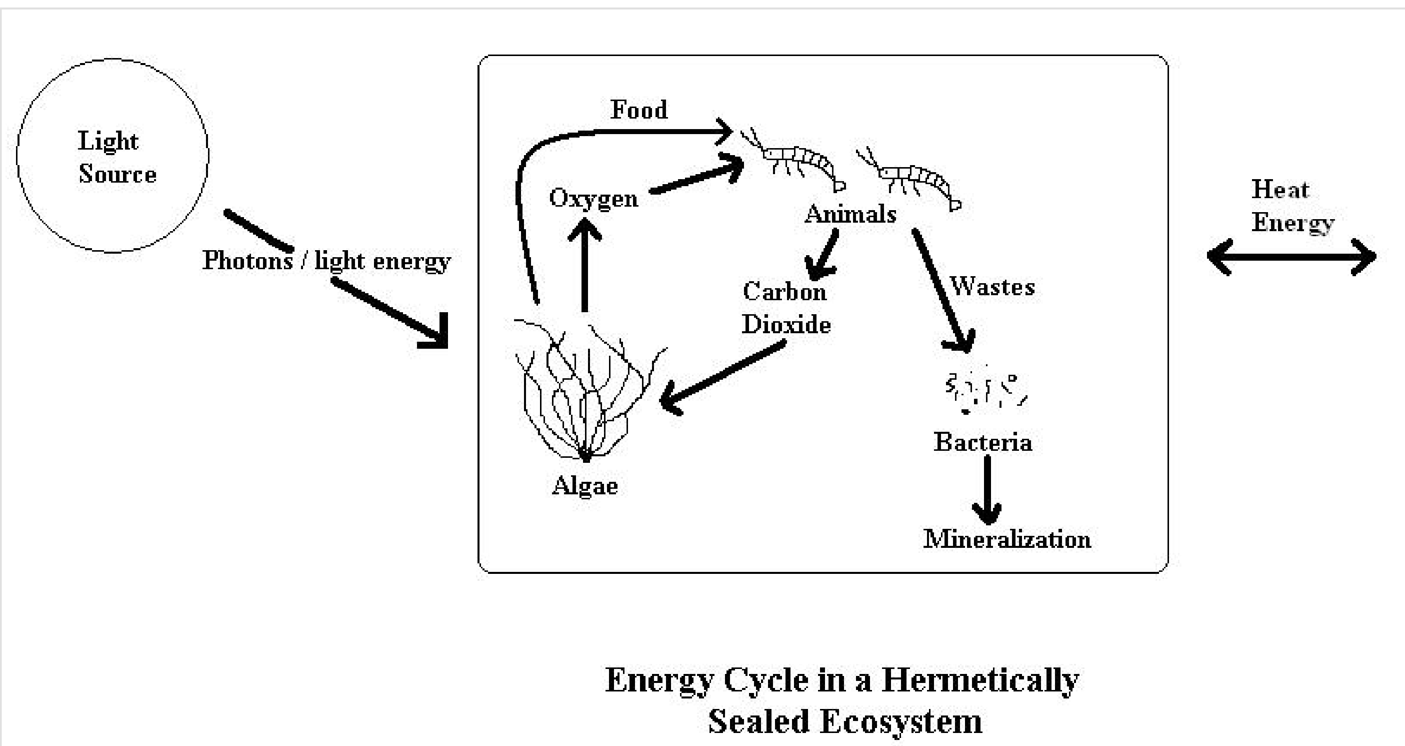


Figure 1. Hermetically sealed ecosystem

with only a light coating of green algae evident - an interesting experiment, but not very attractive.

In a previous life, this carboy had been used as a sealed terrarium with various houseplants. First pea gravel was added to the bottom of the empty carboy, followed by soil mixed with sphagnum moss. Plants were added by means of a long pair of forceps. The plastic cap was finally fitted in place. This terrarium suffered from algae growth on the inside glass of the carboy that could have been removed with either a cloth pad held in a pair of forceps, or possibly with a small aquarium cleaning magnet set. Pruning of the plants proved problematic with certain species overgrowing the others, and dead leaves building up on the surface of the soil.

CLOSED SYSTEMS

Figure two illustrates a closed aquarium system. These differ from a sealed system in that they have some gas exchange with the air in the room in which they are housed. This helps reduce the severe pH shifts previously mentioned. In addition, some of the waste products from the animals are turned into nitrogen gas, which is then allowed to leave the system. Likewise, if the plants require more carbon dioxide than the system can provide for them, more of this gas can be taken from the room air. In all, these systems tend to be just a bit more forgiving than a completely sealed system. Like those, however, the only energy input is light, so that is the only controllable variable. In theory, the ambient temperature of the system could be changed to further control the system; raising the temperature will increase the rate of photosynthesis, while lowering the temperature will reduce the activity of both the plants and animals. The danger here is that the temperature change may end up being outside the range considered normal for the plants and animals that inhabit the system and the whole ecosystem might shut down. Many of the organisms used in these systems are tropical, stenothermic creatures - meaning that they require warm, stable temperatures in which to thrive.

SEMI-CLOSED SYSTEMS

Because waste products tend to build up in water while certain inorganic trace elements are depleted, all closed systems tend to wind down over time. By exchanging some of the water, wastes are removed from the system, while inorganic trace elements are replenished. Figure three illustrates a semi-closed system. The only energy source remains light energy, but now waste products produced by bacteria can be removed and inorganic nutrients (trace elements) are added. The amount of water changes required for these systems varies, and there is no hard and fast rule, but consider performing a 50% water change each month as a starting point. If the plants and animals go into a decline, increase the amount or frequency of the water changes to try to correct the problem.

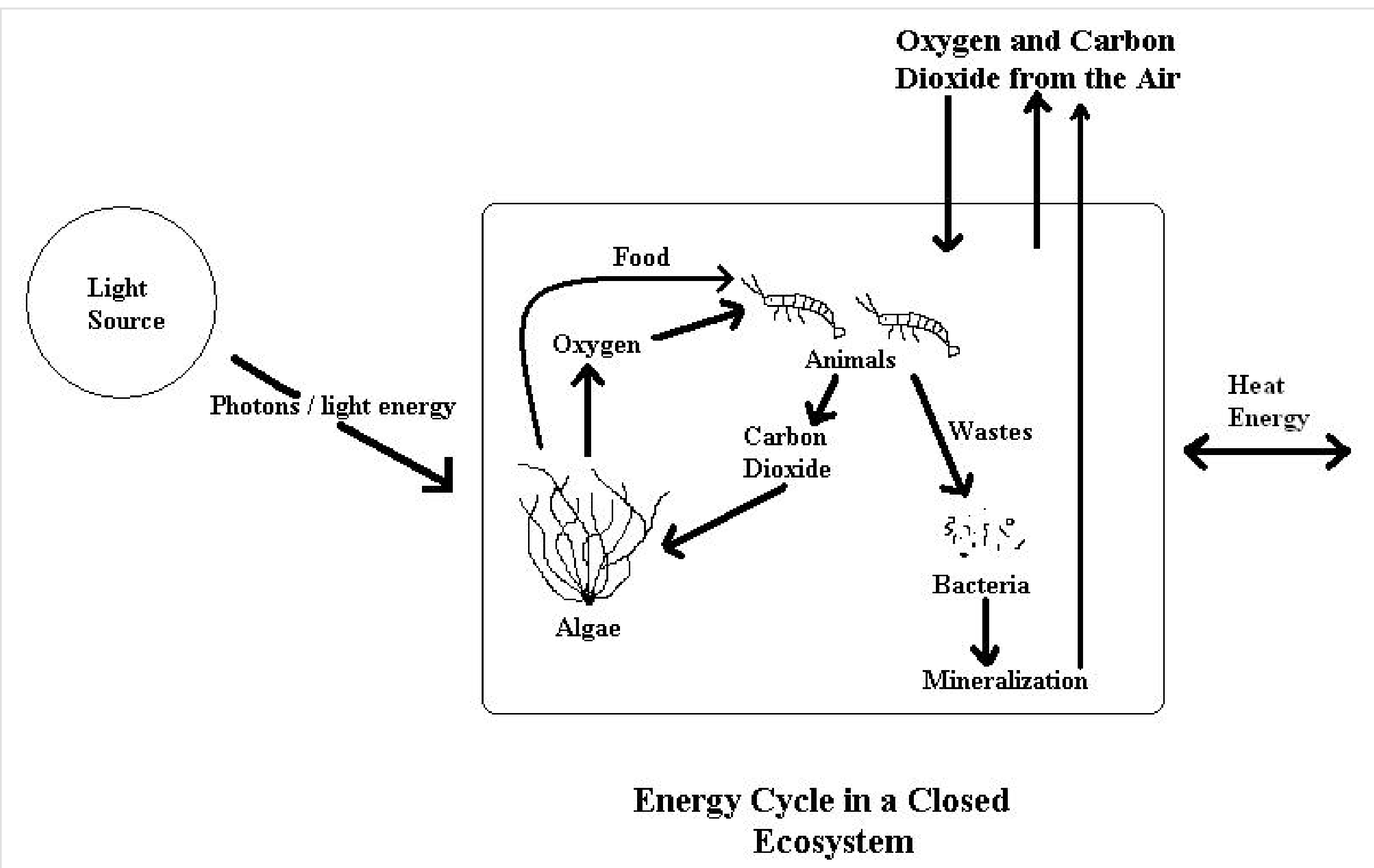
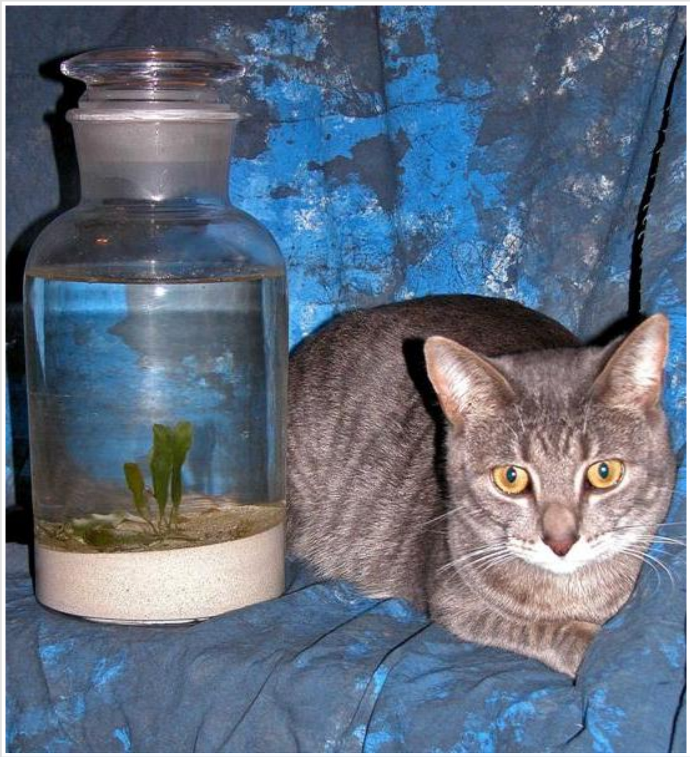


Figure 2. Closed ecosystem.



Gas exchange is managed in this small closed system by periodically removing the lid.

Water changes are easily performed on this six-ounce semi-closed ecosystem.

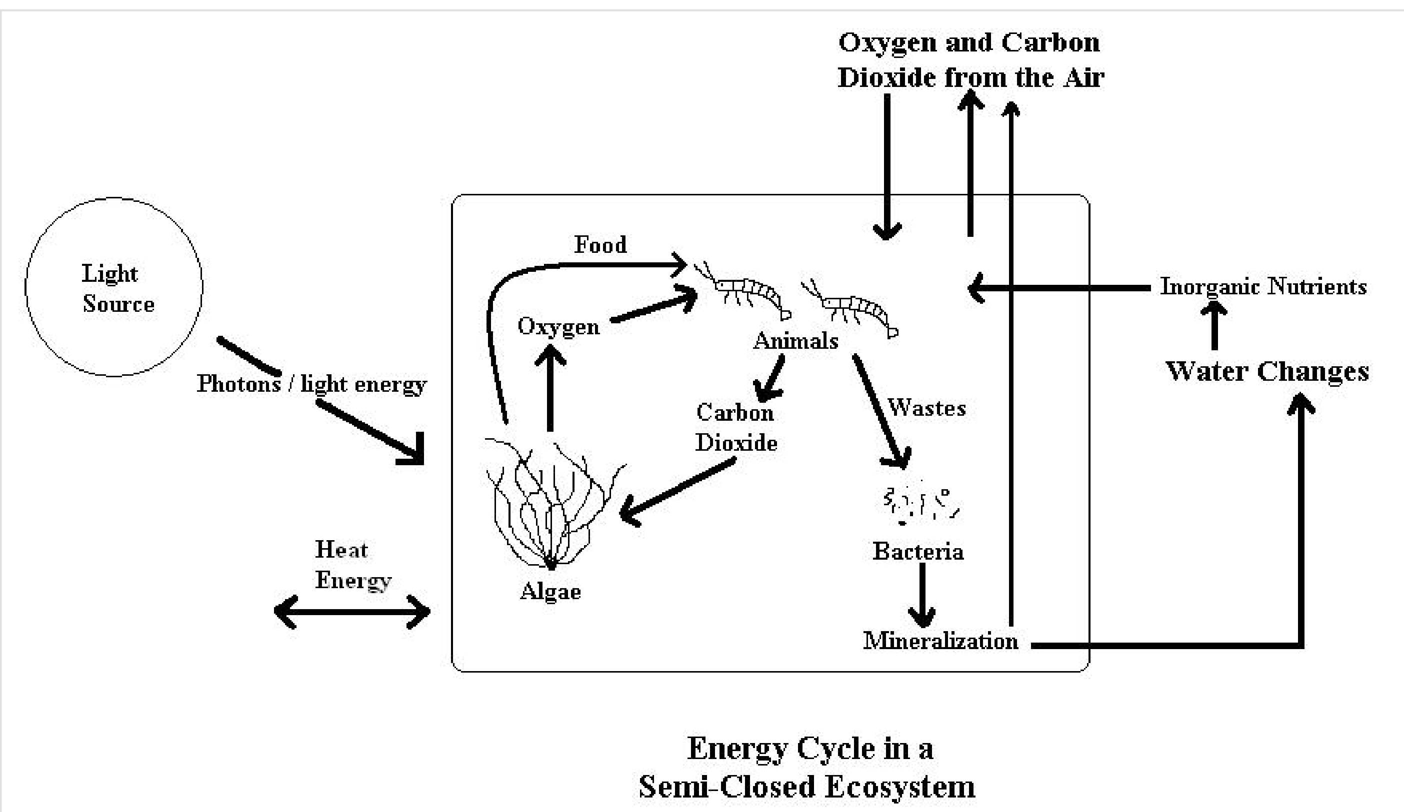


Figure 3. Semi-closed ecosystem.

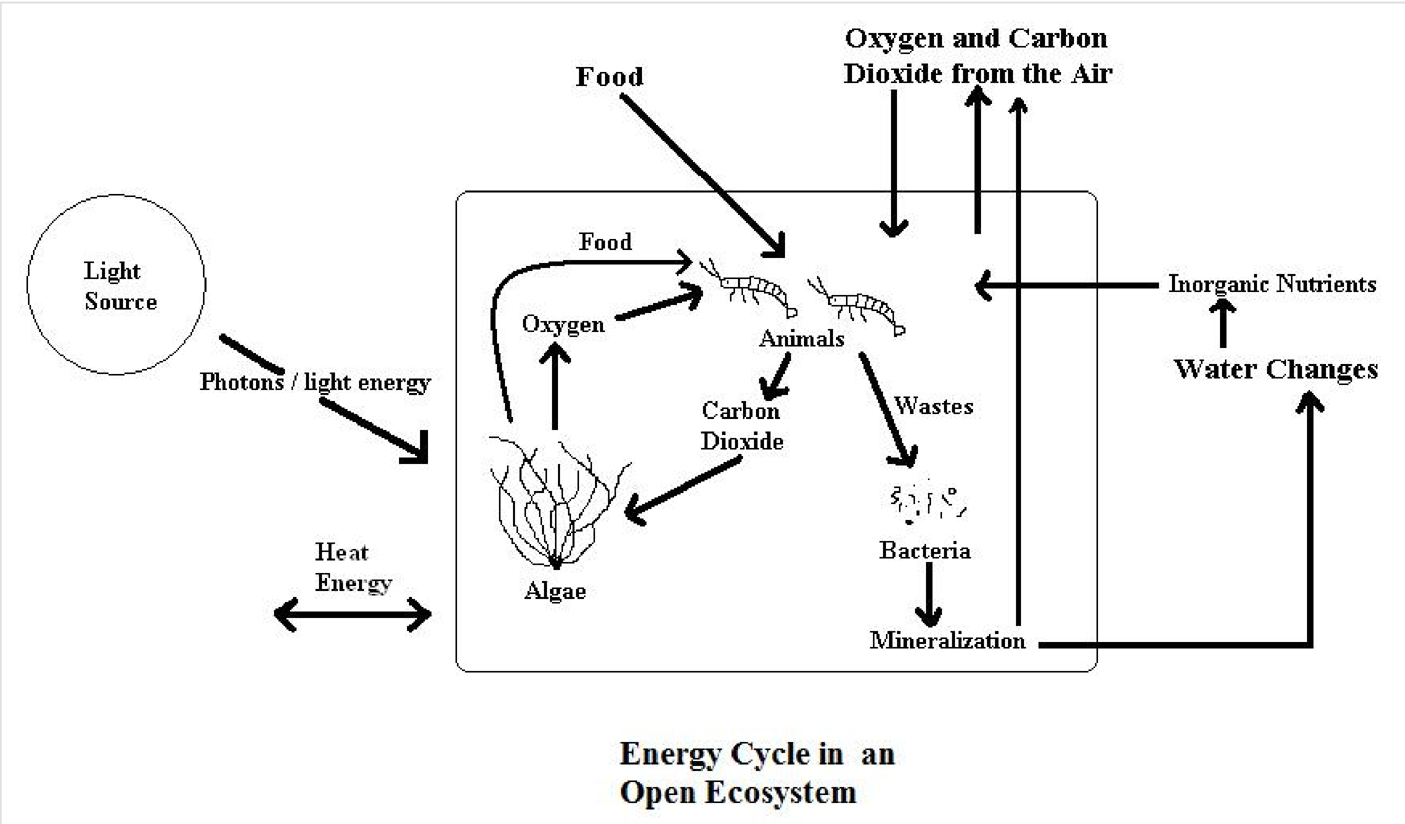


Figure 4. Open ecosystem

Open systems

Finally, figure four illustrates an open ecosystem. These systems have the most liberal requirements of all the closed ecosystems discussed in this article. They are really just aquariums that do not have an active filtration system - relying instead on passive nitrification to detoxify waste products produced by the animals. This is the only ecosystem that you should ever consider adding fish to - and then, only if the system is large enough.

One example of an open system was named FIB by its creator, a public aquarium curator. FIB stands for "Fish In a Bottle". This experiment was a goldfish that lived for over nine years in a glass carboy. No filtration was used, just an open air stem bubbling for aeration. Water quality was maintained through passive nitrification from the bacteria living on the surface of the gravel, as well as frequent and generous water changes. The inside of the glass was cleaned using a scrubbing pad gripped in a pair of tongs. The fish was fed a wide variety of foods including earthworms, mealworms, trout chow and flake foods. Over the years FIB grew to the point that it would no longer fit through the neck of the bottle! FIB was developed as a demonstration of how fish can thrive in small containers when given excellent care, but it was also a very good example of an open ecosystem.

Another commonly cited example of an open system were the "natural" aquariums promoted by the late Lee Chin Eng while living in Indonesia in the 1960's. He was reportedly able to keep all manner of fish, corals and other invertebrates in marine aquariums with no filtration, just a slow trickle of air. We really only have his photographs to document these systems, however quite a bit can be deduced from them by careful observation: Some of the photos show shrimpfish being kept alongside damselfish, clownfish and batfish. Anyone who has successfully kept shrimpfish knows that they do best if fed live mysid shrimp, and cannot compete with those other species of fish for food. Therefore, it seems that Mr. Eng added these shrimpfish a short time before taking the photo - and may have done the same with some of the more delicate invertebrates in his demonstration tanks. Other images of his systems show corals placed in unnatural positions, showing no evidence of any in-situ growth. Many of the other organisms seen are hardy species (at least for the short term) such as feather dusters, carpet anemones and red *Fromia* sp. starfish. Mr. Eng evidently established basic marine aquariums with live rock and sturdy animals, and then just prior to being photographed, he "spruced the tanks up" by adding a few showy, but more delicate species. No magic here, just easy access to clean seawater, live rock, tropical sunlight and lots of cool animals to replace any that died.

Maintenance tips

Since the goal of these systems is self-sufficiency, once they are operating, there is the intent that there should be little intervention required by the aquarist. One exception to this idea is that of pest algae removal.

There is a constant struggle in all of these systems for one species of life to gain the upper hand, and one technique used to accomplish

Six ounce semi-closed ecosystem after one month.

Six ounce semi-closed ecosystem after one year with no maintenance.

this is for algae to grow on the inside surface of the container, effectively stealing the light away from any photosynthetic organisms living inside the container itself. Scientists call this "self-shading" and it occurs in natural systems as well, where free-floating algae grows at the surface, hijacking any light from reaching further down in the water column. In a controlled ecosystem, this means that unless controlled, the ecosystem may end up consisting of a thick coating of algae on the inside surface of the container, and little else. Using biological controls doesn't work well in that adding extra numbers of these species would tend to unbalance the system. For open systems, it is always best to control slime algae by physically removing it with a bit of scrubber pad held with a pair of tongs.

All of these systems will require a great degree of experimentation on the part of the aquarist in order for them to run correctly. Since many aquarists love to tinker and work on "Do It Yourself" projects, this is never a major obstacle. It does however, help to have larger, properly operating aquariums in which to grow various plants and animals that you intend to try out in your ecosystems. That way, if one species doesn't do well, you can replace it with another and try it out instead.

If this topic intrigues you and you eventually decide to try one of these systems, remember to always be sensitive to the husbandry requirements of any animals you intend to add to the system. Don't "push the envelope" by trying to maintain higher animals such as fish in very small closed systems, or overcrowding them, or in other ways risking their lives. Always treat your animals with respect, empathy and the best possible care you that you can.

One final piece of advice that may be contrary to what seems to be common sense; start small; larger closed -eco-systems are **not** inherently more stable (as evidenced by the largest closed ecosystem of all - the Earth). The balance of our Earth is so fragile that humans have caused major disruptions such as global warming, pollution and extinction of species in a very short time. It is presumptuous for any of us then to assume that we can build a large sealed ecosystem that would be stable enough to last for months or even years.

When experimenting with these small scale closed systems, it is vitally important to be backed up by your already solidly operating typical marine aquariums, so that you are better prepared to ultimately succeed with these experimental closed mini eco-systems.

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REEFKEEPING EVENTS

What's Happening in Your Area?

By Advanced Aquarist Readers

Check to see if an event is happening in your area!

Published September 2008, Advanced Aquarist's Online Magazine.

Keywords (AdvancedAquarist.com Search Enabled): Advanced Aquarist Readers, Reefkeeping Events
Link to original article: http://www.advancedaquarist.com/2008/9/events

Do you have an upcoming event?

If so, please email us at feedback@advancedaquarist.com and let us know about it!

West Tennessee Frag Swap and Aquarium Show, September 27

When: Saturday, September 27, 10 AM - 4 PM
Where: 5719 Quince Rd, Memphis, TN 38119 (map)
Phone: 901-359-2199
Website: http://www.wtmrac.org/newfragswap.htm

Come learn more about the marine reef and aquarium hobby. Admission is $3/person. Coral frags for sale or trade. Great raffle prizes! Frag Demo. Table space available for $15 (reserve in advance).

For more information, either call 901-359-2199 or email klug3@comcast.net.

Southern Colorado Marine Aquarist Society Frag Swap, October 4

Date: Saturday, October 4th, 2008
Location: Crowne Plaza Hotel, 2886 South Circle Drive, Colorado Springs, CO 80906 (map)
Website: http://www.scmasfragstock.com/

The SCMAS FragStock will take place on October 4th 2008 at the Crowne Plaza Hotel in Colorado Springs Colorado. This event will feature Marine Livestock (no Fish) and Dry Goods vendors from Colorado as well as national vendors from around the country. The event will take place in the Salon A Grand Ballroom and feature raffle items and amazing corals. Check back frequently as vendors are added to the list. We will also be listing the Raffle items on this site as well. Below is the event layout (subject to change) and some pictures of the Hotel. For more information or if you would like to be a vendor please send an email to Ldogg@thescmas.com.

Reef-A-Palooza (a Southern California Marine Aquarium Society event), October 11-12

When: October 11-12
Website: http://www.reefapalooza.org/index.html

Reef-A-Palooza (RAP) is an annual event promoted by the Southern California Marine Aquarium Society (SCMAS). Now in its fourth year, RAP can best be described as an indoor marketplace where sellers, exhibitors, and hobbyists of all types can buy, sell, trade, showcase their products to the marine hobbyist community. The main purpose of Reef-A-Palooza is to provide an enjoyable, positive atmosphere that is conducive to education and trade of both product and knowledge. As such, participating vendors range from large manufacturers, to retailers, to small livestock sellers, and participating hobbyists range from the beginner to the elite, rare-species coral farmer. It is the perfect venue to showcase new products in the marine aquarium industry as well as retail products for sale. We strive to rally a diverse range of participants into the one-day event so as to present the best value and interest to everyone involved. Considering our current bookings and the popularity of previous years, we expect 60+ vendors/exhibitors and well over 1,000 attendees this year!

Reef-A-Palooza provides the perfect venue for marine aquarium hobbyists to meet fellow enthusiasts, exchange information, and trade, and learn about new products. One of our main goals at Reef-A-Palooza, and within SCMAS, is to educate and enlighten the public with the latest knowledge in marine animal husbandry skills and environmental responsibility. For instance, SCMAS fully encourages the rapid advancement and allure of coral propagation as a viable alternative to wild harvest collection practices. As such, many of our booth vendors are local hobbyists who grow their own corals specifically to sell and trade at Reef-A-Palooza and similar events. SCMAS thoroughly encourages this type of "green commerce" for both the betterment and future of our hobby, as well as the resulting benefit to the marine environment.

Reef-A-Palooza is focused mainly to cater to the vendor and hobbyist, rather than as an educational conference. As such, we tend to attract customers who come specifically for the purpose of buying and seeing all the different exhibitor's booths and displays. Nonetheless, speakers, raffle drawings, and other entertainment are provided to help keep people around for most of the day, even after seeing all the booths. In addition, our promotional and marketing efforts are nearly guaranteed to attract high participation and attendance rates, and hence, heavy foot-traffic throughout the building. RAP 2007 is going to be HUGE this year due to the popularity of its new venue (Orange County Fair & Exposition Center, Building #14) as well as the number of sellers, vendors, and manufacturers involved. We now have 18,000 square feet of indoor, climate-controlled space in which to make this event a resounding success. Now into its fourth year, Reef-A-Palooza has quickly gained the reputation as an event that is NOT to be missed!

New Jersey Reefers Club 2008 Fall Frag Swap & Symposium, October 25

When: October 25, 2008, 10 AM to 6 PM
Where: Crown Plaza Secaucus, 2 Harmon Plaza 07904, Secaucus, NJ (info, map)
Admission: Before October 1st: $25; After October 1st: $30; $40 at the door. 15 and under are free.
Website: http://www.njreefers.org/joomla/index.php?option=com_content&task=view&id=91&Itemid=1

Schedule of Events:

- 9:00 - Vendor Setup
- 10:00 - Doors open
- 11:00 - Guest Speaker
- 12:00 - Lunch/Fragging Demo
- 1:30 - Guest Speaker
- 3:00 - Guest Speaker
- 4:30 - HUGE Raffles
- 6:00 - Cleanup

Guest Speakers:

- Dana Riddle
- Charles Mazel
- Eric Borneman

Admission includes access to:

- Huge Raffles
- Drygoods vendors
- Livestock vendors
- NY Style Deli lunch buffet, snacks, soft drinks

Second Annual Oklahoma City Conference for Reef Aquarists and Saltwater Enthusiasts (CRASE), October 25

When: October 25, 2008, 10 AM to 6 PM
Where: University Central Oklahoma Conference Center
Admission: Adult tickets are $15 each for general admission, $25 with prepaid gourmet box lunch. Children are $10 each for general admission, $20 with prepaid gourmet box lunch.
Website: http://www.mycomas.com/content/view/89/102/

After the fabulous success of CRASE 2007, Aquariums Tropical Fish Supply and the Central Oklahoma Marine Aquarium Society are pleased to announce the second annual Oklahoma City Conference for Reef Aquarists and Saltwater Enthusiasts (CRASE). This will be a single day event and will comprise keynote lectures by distinguished speakers in the area of saltwater aquariums. In addition, the President of COMAS, Dr. Paul Whitby, will be discussing aquascaping. There will also be a hobbyist frag sale, vendor and trade displays as well as numerous door prizes.

The list of prizes is beginning to take shape, please remember to stop by and check as it grows. For now, here are a few of the door prizes we will have:

- Gift Certificates to Aquarium Oddballs
- Gift Certificates to Aquariums Tropical Fish Supply
- Gift Certificates to Zoanuts
- And the Grand Prize this year is: A complete 75gallon Reefready system. This comprises a 75g All Glass mega flow tank (Donated by Aquariums) a custom built Oak Stand and Canopy, 2 4 foot T5 lights, return pump, plumbing for the overflows and a sump. The stand and canopy are not stained so that you can match the system to your house decor. This prize is worth over $1,500.

Guest speakers will be:

- Dr. Ron Shimek: Firstly, it is with great pleasure that the organizers of CRASE wish to announce that --after a great deal of requests from COMAS members---Dr. Ron Shimek will be returning to CRASE. Dr. Shimek will be discussing invertebrates used as clean up crews, commonly available and some not so commonly available. His talk will encompass the pros- the cons- the dos and the don'ts.
- Adam Mangino: The second presenter is a new face to the CRASE. Adam Mangino is one of the ORA team and is primarily involved with their captive breeding program and in particular he is responsible for the hybridization to create the indigo dottyback. He will be talking on captive breeding of marine ornamentals.
- Dr. Sanjay Joshi: Also new to the CRASE is one of the most respected names in reef tank lighting. Dr. Sanjay Joshi has published numerous articles on spectral qualities of bulbs and the effect of various reflectors. It is fair to say the level of expertise he will be bringing to the CRASE is outstanding and I very much look forward to meting him. Dr. Joshi will be discussing various options in reef lighting with particular respect to both T5 and MH technology.
- Dr. Paul W. Whitby: Dr. Whitby is President of the Central Oklahoma Marine Aquarium Society (COMAS) and has over 20 years experience as a saltwater hobbyist. Dr. Whitby will be discussing aquascaping techniques.

Marine Aquarium Expo, April 3-5, 2009

When: Friday, April 3 - Sunday, April 5; 12:00 PM - 6:00 PM
Where: OC Fair & Event Center, 88 Fair Drive, Costa Mesa, CA 92626 (map)
Phone: 714-708-1500

Admission: $10 for Adults, $5 for Seniors, and FREE for Children 12 and under
Website: http://marineaquariumexpo.com/

Marine Aquarium Expo" (MAX), is southern California's premier indoor consumer-tradeshow, bringing together manufacturers, retailers, and saltwater enthusiasts from all over the nation into one giant, centralized location. More than 100 booths fill 22,000 square feet of exhibitor floor space plus another 7,000 sq. ft. of covered courtyard to accommodate speakers, raffle drawings, Club booths, and various workshops. MAX is the perfect venue to see the latest innovative products and offerings as well as the most progressive enterprises in the marine aquarium business. MAX is a spectacular marketplace for selling/trading of livestock, equipment, supplies, and various other goods. Literally THOUSANDS of coral frags are available for sale from the dozens of livestock exhibitors attending Marine Aquarium Expo. We invite you to bring the entire family to see what the excitement is all about. MAX is an event that you do NOT want to miss!

- Two Full Days of festivities, trade, and entertainment! Do not miss this event!
- Giant Market of Manufacturers, Wholesalers, Retailers, Hobbyists and more!
- Livestock Dealers selling corals, frags, fish, invertebrates, and more
- Courtyard classes provides a wealth of entertainment and learning experiences
- Many booths, workshops, and educational displays represented by clubs and charities
- Huge Drawing both days with many, many, Major Prizes to WIN!
- Manufacturers showcasing the latest equipment, products and services available!
- Six Speakers from all over the United States come to demonstrate, educate, and inspire

LATERAL LINES

Blundell Buttons Part II: The Present

By Adam Blundell M.S.

And for anyone still wondering - the original colony is still alive and doing well now a nearly a decade later in the original tank.

Published September 2008, Advanced Aquarist's Online Magazine.

Keywords (AdvancedAquarist.com Search Enabled): Adam Blundell M.S., Coral, Lateral Lines, Propagation, aquaculture, captive breeding
Link to original article: http://www.advancedaquarist.com/2008/9/lines

In Blundell Buttons Part I (http://www.advancedaquarist.com/2008/8/lines) I recounted the beginnings of the Blundell Button Project. This article describes how the project has gone, and what unforeseen adventures followed.

The Project

The project goals were discussed in article one, but now we will look at how well they worked. To recap, they are:

1. I started with this coral and fragged off a couple of polyps. These polyps were then given away free to active members in my local aquarium club (Wasatch Marine Aquarium Society).
2. I gave explicit instructions to each person receiving polyps that stated that these corals were to never be sold. They were to be grown, fragged, and shared with others.
3. The new keepers were told that these corals were to be shared only with advanced aquarists who had the best chance of keeping the chain going. These second generation, third generation, forth generation, etc. owners were to continue the chain of producing free corals to expert reef keepers. A sort of pass it along free type of project to ensure survival.
4. The new keepers of these corals were to explain to the next person (and so on down the chain) that these corals were to be grown as part of a project to document how well or how poorly corals are aquacultured and distributed. Therefore we wanted everyone to track where the cultured polyps were going from owner to owner down the line.

Starting the Chain

This process was a huge initial success. I personally fragged many of these polyps and tracked the ownership of them. These new owners did a great job of growing the corals, propagating them, and tracking where they went. But that was about it. It took less than a year to see the difficulties in tracking the coral. Hobbyists move, tanks get changed over, and breaking the chain is quick to happen.

Free Frags

This lasted longer than the chain process. For several years (about 4 to my memory) these corals were being fragged for free and given away. At one point a couple hobbyists started asking for $10 per frag. The purpose of this was to "weed out" all the requests and hopefully be left with the serious hobbyists. Unfortunately during the past couple of years this has turned sharply for the worse. A recent cuil search for "blundell button sale" presented dozens of corals for sale. In fact I was able to find Blundell Buttons for sale on 13 websites, in at least 4 states (origin of all websites was unknown). The price… outrageous (at least in my opinion). At $50 per polyp on many sites I found this coral atop the list. In fact small colonies were several hundred dollars, which competes with all but the highest of corals.

Passing On To Advanced Hobbyists

This didn't go so well. How can you say "no" when a hobbyist is willing to give you a couple hundred dollars for a few little frags? With all great intentions of spreading this coral it soon became a game of who had the money.

Documenting the Chain

Within my local club this wasn't difficult for the first few years. But as I said before as people left the hobby their corals were divvied out and often became dead ends in the record books. As of now, I

Shown here near the original collection site another colony of Blundell Button's located and photographed 2 months ago.

can only physically track but a few specific frags which have endured the past decade.

The Name Goes On

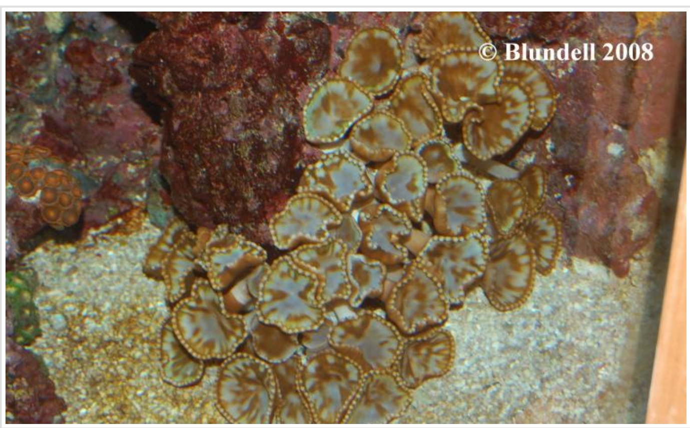
I think it is worth while to tell a little story here. Earlier this year I attended the Midwest Frag Fest in Rockford Illinois. *Side note- fabulous event, I highly recommend you attend as the club members work very well together to make this successful.* During this event I found a hobbyist selling "Blundell Buttons." They were well labeled and prominently displayed, but no price was listed on the tank. I asked how much, and was told they are $10 per polyp (mind you that is less than half what they sell for back home to me). I then asked the hobbyist "why are they called Blundell Buttons?" The response was all too entertaining. At no time during this conversation did the hobbyist notice my giant nametag hanging around my neck. Anyway, he said something like "Oh I think they were named by Steve Tyree as one of those limited edition corals." An answer I'll have to share with Steve Tyree the next time I see him.

More Mythology

Along the same lines as the Steve Tyree answer I've read some whoppers. When a hobbyist posted on an online site asking where the name came from a group of very clever and witty hobbyists jumped on board. With obvious sarcasm and imagination they began to type. Here are a few of the examples I found most entertaining to read:

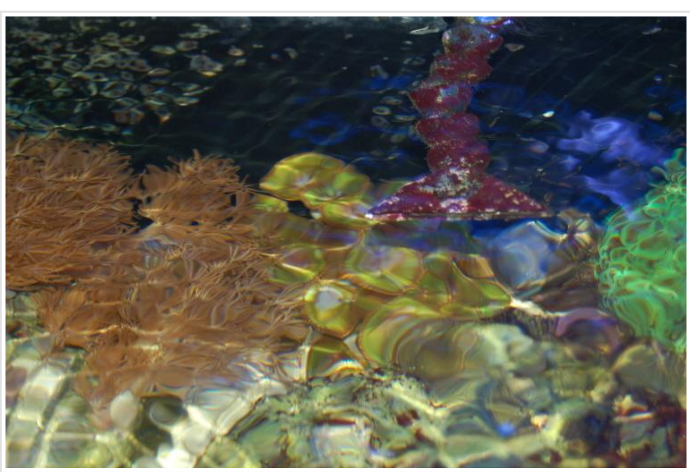
Jake Pehrson:

Here is the real story. Adam was doing some "research" in the Caribbean. When he came home Marzena said "Adam, you smell really bad". Which was understandable seeing how Adam hadn't changed his clothes or taken a shower for the entire trip. Adam headed directly to the shower. When he was removing his swimming trunks he noticed something in his pocket. He pulled it out and it was still alive (barely). Luckily his shorts didn't have those little holes in the bottom of the pockets to drain the sea water out of them. Adam quick threw the animal in the nearest aquarium and to his amazement it lived. He quickly began selling this coral to the members of the club as a cure to everything that ails your aquarium (ich, velvet, Aiptasia). He started with the low price of $1000 and named them "Blundell Buttons" Although it really didn't cure anything many people in the club were now stuck with this coral and out $1000. In order to recoupe their money they have been propagating and selling this coral (for a nominal fee) for many years.

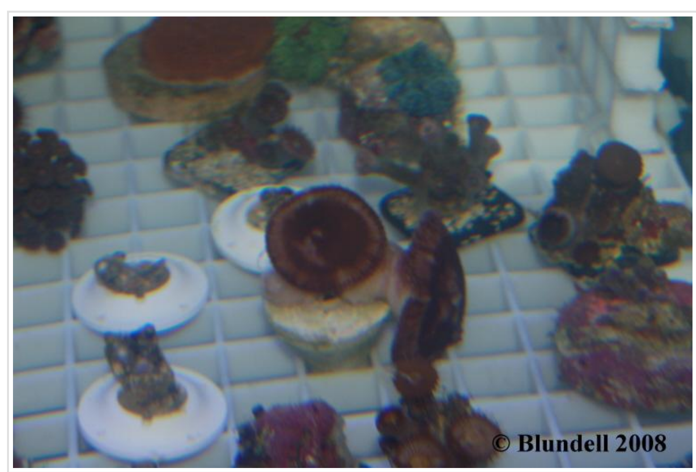


This colony is located in a local fish store and serves as the mother colony for many frags.

And with eager hobbyists lined up for frags it apparently warrants a high price.



Shown here the center coral (green and brown) is a fragmented colony for sale.



Shown here a couple Blundell Button polyps are displayed for sale at a large aquarium conference (the Midwest Frag Fest).

Tim Hemmingway:

I heard a version of the story very similar to yours (Jake Pehrson), but if I remember correctly, when Adam removed his swim trunks he found the coral attached to him... so he had to sit in a bath of salt water for a week with a powerhead pointed at him until the coral let go and then he put it in his tank...

Jason in Orem:

I heard you were in a science lab doing some research on some green button palys when you had an overwhelming sensation of hunger come upon you. The only thing that was in your reach were the green buttons. You took a monster bite out the buttons and quickly realized that it wasn't a 24oz T-bone. You put the buttons back in the holding tank. As the the Blundell DNA mixed with the green button DNA a new hybrid was formed. The Blundell Button. Just what I heard.

Jamison Hensley:

How can so many people get the story so wrong? While it is true that this happened in the Carribean, the rest is way off. Not that nomenclature is all that important, but the original name of the coral in question, was actually Magrando Stempornida which in a little known local dialect means Super precious water flower.

This beautiful coral used to grace the reefs in abundance until pirates discovered their magical properties and pillaged the natural environment of this precious gem. What few clonies survived the pirates, were then desimated by the untimely tropical storm Geraldo.(who apparently thought Jimmy Hoffa was burried in the reef) The carnage left but one remaining colony in a shallow tidal pool. Until Adam's trip, locals would arrive semi-annually to pay homage to it and would sprinkle it with phytoplankton in hopes that it would make a come back.

While in the Carribean, Adam decided to go on a guided snorkeling tour with a non-English speaking native diving expert ironically named Poshspice. (Ironic because although Adam loves the Spice girls, he's always had a thing for Scarey Spice). There was an immediate fraternal bond between the two snorklers and they referred to eachother by last name only, as a customary sign of utmost respect.

While snorkeling (in his water wings), Blundell was nonchalantly stepping on what would have been ultra rare, Tyree colonies of Acans, Chalices, and Pepto-safecracker-alien eye-toxic-nuclear-rainbow Table Acros for a better look at what was either Hair algea or what used to be the contents of Poshspice's (last name - Smith) stomach after a long night with Captain Morgan. (again, they simply call it Morgan out of respect) In his excitement, Adam neglected to notice a dime sized jellyfish snuggling up to his forehead.

With an under-water scream (again, I hate to point out how ironic this is) that sounded a lot like a Spice Girls song, Adam surfaced and crawled onto the top of the reef and settled into a surprisingly comfortable impression in the rock while waiting for Smith to implement the time tested practice of "taking the sting out". After administering a rather messy, but healthy dose of "Vitamin P", Smith noticed that Blundell was sitting right on top of the precious colony of Palythoas. In his grief-stricken broken English, Smith howled, "Blundell... Butt-on!!! Blundell... Butt-on!!!" (Translation: Hey doofus, you're sitting on our national treasure.

Adam was quite embarrassed when he noticed that all but 3 polyps has been squished beyond recognition. With what dignity he could still muster, he quickly plucked the remaining 3 "Blundell Buttons" and promised to propagate and share (for $750 a polyp) this sacred coral to enthusiasts world wide.

Though Poshspice's village was subsequently destroyed by an unparalleled and unexplainable plague of ravenous Pipefish, we can all now appreciate this beautiful coral in our own homes.

And finally my favorite part of the mythology from Jason in Orem…

Conclusion

In the end, I'm not sure if the project worked. I'm very pleased to see the early documentation of coral fragging. The idea that a coral can be brought into the marketplace and grown and aquacultured for many years has certainly been proven. It does give hope for a sustained "zero impact" hobby.

However it is incredibly ironic that a high priced coral has my name attached to it, which is one of the very things I find upsetting in this hobby.

And for anyone still wondering – the original colony is still alive and doing well now a nearly a decade later in the original tank.

Author Information

Adam Blundell M.S. is a hobbyist, lecturer, author, teacher, and research biologist. Adam is the director of the Aquatic & Terrestrial Research Team, a group which bridges the gap between hobbyists and scientists. Adam can be reached by email at adamblundell@hotmail.com.

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By Marineland

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